2015 State of the Environment Report

air | climate | land | forest | water

Government of Saskatchewan

State of the Environment Reporting in Saskatchewan

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Minister's Message

On behalf of the Government of Saskatchewan and the Ministry of Environment, I am pleased to present Saskatchewan's 2015 State of the Environment Report, the thirteenth published in our province.

The outlook for Saskatchewan's future is strong. Our population and economy are both growing and global demand for our resources is high. These changes however, increase the pressures on our air, land and water.

As with the first edition in 1991, state of the environment reporting offers accessible, objective and comprehensive information to improve our understanding of the environment, its health amid unparalleled economic growth, and provides the basis for sustainable and informed decision-making for future generations. I am confident this report fulfills these objectives.

Building on the 2011 and 2013 *State of the Environment Reports*, the 2015 edition is structured around five major themes that assess Saskatchewan's natural environment: air, climate, land, forest and water. The report highlights some of the innovative and positive responses by the ministry and its partners to address some of these environmental challenges.

These responses align with the Saskatchewan Environmental Code. This new results-based approach will allow industry and communities the flexibility to come up with innovative solutions to achieve or surpass clearly-defined environmental outcomes. The first edition of the code takes effect in 2015, and allows the ministry to focus its resources on activities that pose the greatest environmental risks.

Results-based regulation relies on measurement of results and identification of improvement opportunities. State of the environment reporting complements those needs and will continue to evolve to reflect innovation, transparency and accountability in assessing the condition of the environment and the forces acting upon it.

The *2015 State of the Environment Report* demonstrates the government's commitment to sustainable growth, and the Ministry of Environment's mandate to manage and protect Saskatchewan's environment for the well-being of the province, its people and its future.

Scott Moe
Minister of Environment

Environment By the Numbers

The themes and indicators featured in this report provide a broad picture of Saskatchewan's environmental status and trends and highlight ongoing efforts by government, industry and organizations to manage the province's resources and conserve its natural heritage. Following are a few examples of the report's findings and trends using the Condition-Stressor-Response model for assessing environmental performance.

Saskatchewan has an abundance of space, fertile soils and natural resources. Cities are smog-free, forests are healthy and productive and the environmental health of agricultural lands is improving.

AIR QUALITY CONSIDERED GOOD to EXCELLENT

for Saskatchewan's major urban centres of Regina, Saskatoon, Prince Albert and Swift Current. *(page 11)*

197 million dollars in **CROWN LAND SALES** in Saskatchewan for 2014 *(page 36)*

89% successfully regenerated harvested forested areas in Saskatchewan. *(page 63)*

12% of Saskatchewan's surface is covered by water and 7 per cent of Canada's fresh water can be found here. *(page 68).*

8.0% DECREASE IN GHG EMISSIONS while GDP grew by 16 per cent during the 2006 to 2012 period, through decoupling of GHG emissions from economic growth. *(page 24)*

$60 MILLION
in GoGreen funding

The Go Green Fund provided $60 million in funding support to more than 60 projects to demonstrate new environmental technologies and processes during the 2008/09 – 2014/15 period. *(page 26)*

42
WILDFIRE DETECTION CAMERAS

Across the province's northern forest – the largest wildfire detection camera system in North America. *(page 65)*

From 2012 to 2014

82%
OF ALL DEPOSIT-PAID, READY-TO-SERVE BEVERAGE CONTAINERS SOLD WERE RECYCLED

Saskatchewan has the highest return rate of all beverage container programs in Canada. *(page 41)*

REPRESENTATIVE AREAS NETWORK

There are currently 6.2 million hectares (approximately 9.5 per cent of the province) in the Representative Areas Network. *(page 40)*

44,817 TONNES
of solid waste

In 2013, 19,120,254 litres of waste liquid and 44,817 tonnes of solid waste were diverted from landfills. *(page 43)*

Many indicators have pointed toward opportunities to improve the state of the environment. As the Ministry of Environment moves forward in using a results-based regulatory approach, the information in this report will be used to help set future priorities in measuring the health of key components of the environment.

State of the Environment Reporting in Saskatchewan

Introduction

This is the thirteenth State of the Environment report for Saskatchewan; the first was published in 1991. Progressive reports since 1991 (Table A) have focused and reported on the condition and trend of various key components of the environment from both a regional and provincial perspective. The *Saskatchewan 2015 State of the Environment Report* identifies the status and key trends for five environmental themes that build on the 2011 and 2013 reports:

air | climate | land | forest | water

Table A - State of the Environment Reporting in Saskatchewan, 1991-2011

Year	State of the Environment Report	Focus
1991	State of the Environment Report	Broad picture of the condition of the environment and areas of concern
1993	The Need for Environmental Indicators	'Concept' document
1995	The Boreal Plain Ecozone: A Forest Community	Described current environmental trends, conditions and emerging issues from a regional 'Ecozone' perspective
1997	The Prairie Ecozone: Our Agricutlural Heartland	
1999	The Boreal Shield Ecozone: A Land of Lakes and Forests	
2001	The Taiga Shield Ecozone: Land of the Caribou	
2003	A Provincial Perspective	Provincial overview of previous four reports
2005	State of the Environment Report	Assessed the state of selected environmental components
2007	State of the Watershed Report	Assessed watershed health
2009	State of Saskatchewan's Provincial Forests	Assessed how well forest values are being sustained
2011 2013 2015	State of the Environment Report	Framework of five environmental themes and 17 key indicators to assess and report on the environment.

Note: Reports listed fulfill the Government of Saskatchewan's legislated commitment to report on the state of the environment every two years.

Background

There is increasing awareness of the fundamental dependency on ecosystem services for quality air, land, water, food and other resources, and impact through the pressures of resource use and the emission of pollutants to air, land and water. State of the environment reporting is an internationally accepted approach to assess and improve our understanding of the environment, to monitor its health, and to inform actions for better management.

The *2015 State of the Environment Report* provides timely and accessible information about the condition of Saskatchewan's environment and pressures acting upon it. The purpose of this information is to raise awareness and understanding of the environment, identify emerging issues and trends, and to highlight the actions needed by the public, First Nations and Métis communities, industry, business, government and non-government organizations to improve the way we use and manage the environment.

Saskatchewan legislation mandates the preparation and tabling of a provincial State of the Environment report every two years as required by *The State of the Environment Report Act, 1990* and *The Environmental Management and Protection Act, 2010*. In addition to state of the environment reporting, both the Saskatchewan Ministry of Environment and the Water Security Agency produce annual plans and reports in which various performance indicators are highlighted and tracked.

Reporting Framework

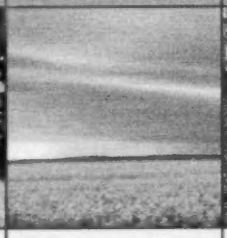
The *2015 State of the Environment Report* uses a framework of environmental themes and selected key indicators, established in 2011 and reported in 2013 to assess and report on the environment. The *2015 State of the Environment Report* is organized around five major themes: air, climate, land, forest and water (Table B). Reported within these five themes are 17 environmental indicators that provide a broad overview of the status and trends of Saskatchewan's natural environment.

As with previous Saskatchewan State of the Environment reports, the **'Condition-Stressor-Response'** model forms the basis for reporting.

The **'Condition-Stressor-Response'** is an internationally accepted approach for assessing environmental performance.

- **Condition** (or state) refers to the quality of the environment and the functioning of important environmental processes. Condition indicators are used to illustrate the environmental state at any point in time or as a trend.
- **Stressor** (or pressure) refers to human activities that affect the environment. Stressor indicators measure these human activities that impact the condition of the environment.
- **Response** (or actions) refers to initiatives to address pressures on the environment or to improve or maintain its condition. Response indicators represent the management programs and planning activities implemented to improve the condition or state of the environment and to mitigate the stresses. Response indicators measure the success (or outcomes) of management actions or strategies

Table B - 2015 State of the Environment Framework - Themes and Indicators

air	climate	land	forest	water
				
Air Pollutant Concentration	Greenhouse Gas Emissions	Agricultural Land Cover	Forest Type and Age Class	Surface Water Quality
		Mineral Disposition Activity	Forest Wildfire Disturbance	
Air Pollutant Volume		Area Under Zero-tillage	Forest Insect and Disease Disturbance	Surface Water Quantity
		Private Land Stewardship	Proportion of Sustainable Harvest Level Utilized	
Air Zone Management		Waste Recycling	Forest Regeneration	Water Consumption and Conservation

The basis for the Saskatchewan 2011, 2013 and 2015 State of the Environment reports and selection of the reporting themes and indicators were determined by the following criteria:

- Comparison of reporting approaches, frameworks and indicators from other jurisdictions, including British Columbia, Alberta, Northwest Territories, Australia, New Zealand and the United States.
- Themes such as air, land and water represent parts of the environment or a natural grouping of natural resources and are the main components that come to mind when we think of the environment. The use of themes in the 2011 State of the Environment Report assisted with structuring the report, including streamlining and grouping indicators to more directly relate to the themes.
- The core environmental indicators were chosen from a review of a wider set of indicators from past Saskatchewan reports, especially the 2009 State of Saskatchewan's Provincial Forests, the 2007 and 2010 State of the Watershed reports, and the 2003 and 2005 State of the Environment reports.
- The 17 indicators found in this report were also selected for their ability to provide:
  - the best representation of information that is currently available;
  - data that is relevant, analytically sound, credible and measurable;
  - comparable data between reporting periods and of sufficient quality to describe changes or trends; and
  - comparison between reporting periods, and sufficient quality to describe changes or trends.

Key Highlights

The themes and indicators found in this report provide a broad picture of Saskatchewan's environmental trends and ongoing efforts by government, industry, business and organizations to manage the province's resources and conserve its natural heritage. Unlike many other areas in the world, including some parts of Canada, Saskatchewan has an abundance of space, fertile soils and natural resources. The outlook for Saskatchewan's future is bright. Its population and economy are both growing and global demand for its resources is high.

However, challenges remain to maintain and improve the province's environmental quality well into the future. Many indicators have pointed toward opportunities to improve the state of the environment and to areas where more information or additional indicators are required.

One of the key features of the new results-based regulatory system will be the Saskatchewan Environmental Code, a clear, concise statement of objectives, recommended practices and alternatives that will govern the management and protection of Saskatchewan's environment and natural resources while promoting economic growth *(Saskatchewan Ministry of Environment, 2013)*.

With the implementation of the Environmental Code, the Ministry of Environment is moving forward with a results-based regulatory approach. As such, the information in this report will be used to help set future priorities in measuring the health and state of key components of the environment.

The code will provide clear directions and guidelines for developing projects, allowing operators in many low-risk situations to proceed without waiting for the ministerial approval process.

The Saskatchewan Environmental Code is a new approach that will allow industry proponents and communities the flexibility to come up with innovative solutions to achieve or surpass clearly-defined environmental outcomes. The first edition of the code takes effect in 2015 and allows the ministry to focus its resources on monitoring and compliance of activities that pose a higher risk to the environment and to human health and safety.

air

Key Points

- The Ministry of Environment continuously monitors air quality in the province.
- Air quality in Saskatchewan's urban centres is primarily excellent.
- In many regions, levels of air pollutants are generally considered low.
- Local stakeholders continue to be actively engaged through five established air management zones in the province.

Clean air is vital to the health and well-being of Saskatchewan's people and the natural environment. 'Air' is the everyday term for the atmosphere — the layer of nitrogen, oxygen and other trace gases that surround our planet and make life on Earth possible. Air pollutants in Saskatchewan originate from local, regional and global sources where major influences on air quality include industrial emissions, vehicle emissions, forest fires and agricultural operations. Air quality depends on the rate at which pollutants are emitted into the atmosphere and the ability of the atmosphere to disperse these pollutants. As a result, air pollution can be pervasive and does not recognize property or political boundaries.

Poor air quality can affect human health, the environment and the economy. The very young, elderly or those with compromised immune systems are often the most susceptible to air pollution. Asthma, lung cancer, cardiovascular disease, allergies and other human health problems have been linked to, or can be worsened by, poor air quality. Impacts on plant and animal biological diversity and productivity have also been attributed to pollutants in the atmosphere. Air pollution can have an impact on our economic well-being. The desire to prevent air pollution can affect decisions about what we buy, what we use, and how or where it is produced. Repairing the damage caused by air pollution, including health and environmental problems, can have economic implications. On the other hand, the creation of new technologies, knowledge and jobs to address air quality concerns can produce economic opportunities.

Indicators for Air

Condition

1.1 Air Pollutant Concentration (reported as an Air Quality Index) – describes the general air quality in Saskatchewan and informs the public about the condition of air in their area in real-time using an index that contains the measured quantities of various pollutants.

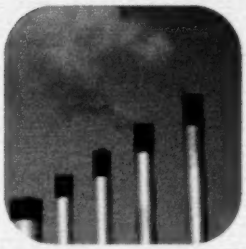
Stressor

1.2 Air Pollutant Volume – tracks the total amounts of major air pollutants released annually in Saskatchewan.

Response

1.3 Air Zone Management – outlines an important continuing place-based approach to maintain clean air and ensure effective and efficient air monitoring to complement existing regulatory tools to minimize adverse effects on air quality. Place-based approaches can be defined as stakeholders (in this case the public, industry, communities, non-government and government) involved in a collaborative process to address issues as they are experienced within a geographic space, be it a neighbourhood, a region or an ecosystem (Policy Horizons Canada, 2011).

1.1 Condition Indicator: Air Pollutant Concentration (Reported as an Air Quality Index)



Why is this indicator important?

Measuring and evaluating air quality is an important activity in maintaining Saskatchewan's air quality. The Air Quality Index (AQI) describes the general air quality in Saskatchewan by transforming ambient concentration measurements of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO) and fine particulate matters ($PM_{2.5}$) into a single number, or index, that represents the measured quality of the air. The index is also used to monitor long-term trends in air quality. Table 1.1 provides a description of the categories of AQI results.

Table 1.1 Air Quality Index (AQI) Rating System

AQI Rating	AQI values	Effects
Excellent	0 – 15	No known harmful effects to soil, water, vegetation, animals, materials, visibility or human health.
Good	16 – 25	No known harmful effects to soil, water, vegetation, animals, materials, visibility or human health. Persons with severe respiratory ailments sensitive to air pollution may notice some minor effects.
Fair	26 – 50	Adequate protection against harmful effects to soil, water, vegetation, animals, materials, visibility and human health. Persons with severe respiratory ailments sensitive to air pollution may need to modify their usual outdoor activities if experiencing effects.
Poor	51 – 100	Not all aspects of the environment and human health are adequately protected from possible adverse effects. The general population should consider reducing or rescheduling strenuous outdoor activities and higher-risk populations should reduce or reschedule outdoor activities.
Very Poor	value >100	Continued air quality in this range could pose high risk to environment and public health.

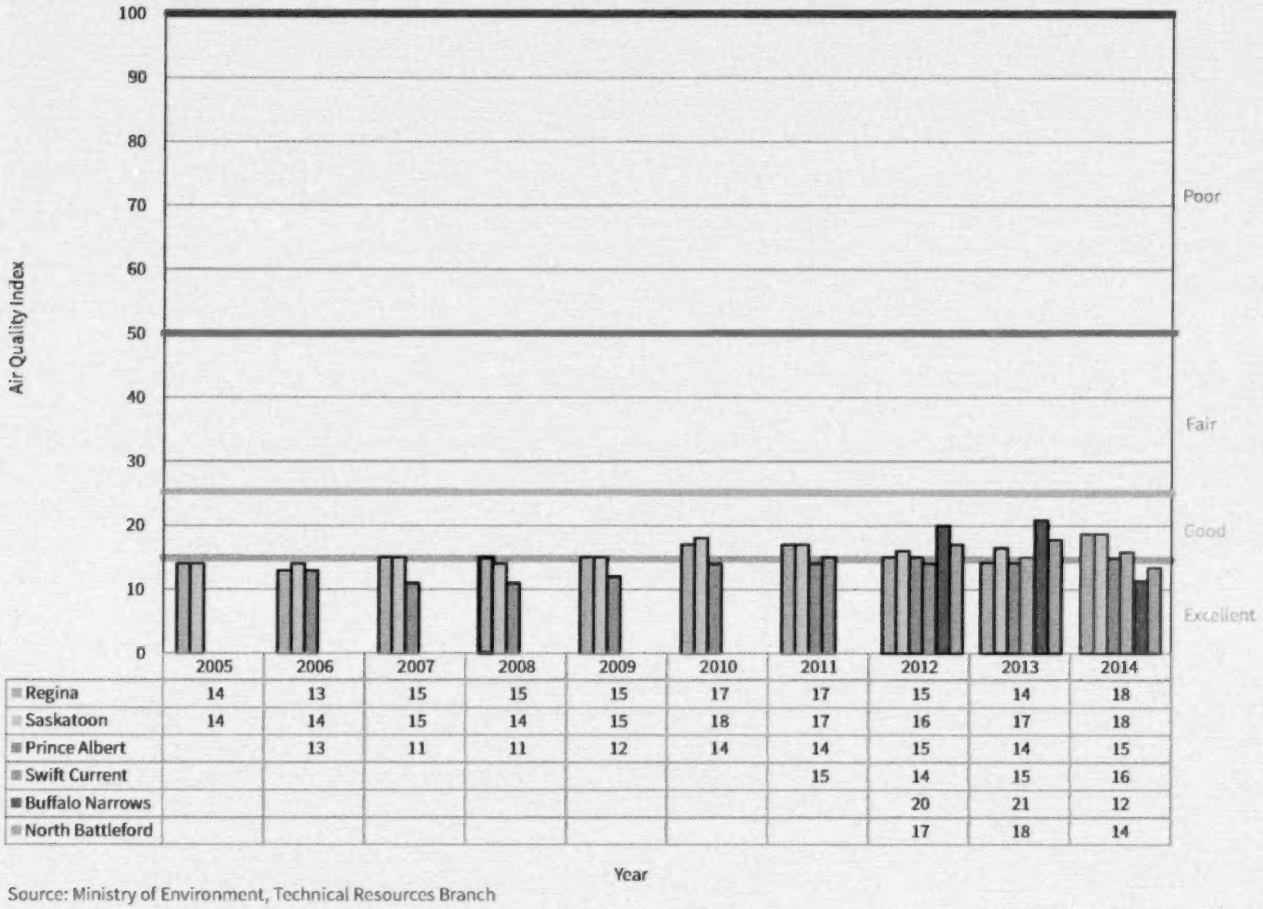
Source: Ministry of Environment, Technical Resources Branch

What does this indicator show?

Yearly averages of Air Quality Index ratings have been determined for Regina and Saskatoon from 2005 to 2014, for Prince Albert from 2006 to 2014, Swift Current from 2011 to 2014 and for Buffalo Narrows and North Battleford for 2012 to 2014 (Figure 1.1).

The indicator shows that air quality in Saskatchewan is primarily excellent with no anticipated harmful effects. The AQIs for Regina, Saskatoon, Prince Albert and Swift Current have consistently rated good to excellent and there has been a relatively stable trend in this measure. The slightly elevated levels in 2010, 2011 and 2014 for Regina and Saskatoon are due to higher particulate matter levels caused by forest fire activity in the province and in other parts of the country. Forest fire smoke results in short-term poor air quality and consequently the AQI is slightly higher than what is typically recorded. A noticeable decrease in the AQI was recorded in 2014 compared to 2013 at the Buffalo Narrows location. This was due to a software problem with the $PM_{2.5}$ sampler with data being lost. A predicted AQI would have been closer to 2013 values.

Figure 1.1 Annual Air Quality Index ratings for Regina, Saskatoon, Prince Albert, Swift Current, Buffalo Narrows and North Battleford, 2005-2014



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Regina	14	13	15	15	15	17	17	15	14	18
Saskatoon	14	14	15	14	15	18	17	16	17	18
Prince Albert		13	11	11	12	14	14	15	14	15
Swift Current							15	14	15	16
Buffalo Narrows								20	21	12
North Battleford								17	18	14

Source: Ministry of Environment, Technical Resources Branch

What actions are being taken?

The Ministry of Environment ensures new industrial developments use the most appropriate technology to reduce air emissions. The ministry conducts continuous air quality monitoring at six sites in the province — Regina, Saskatoon, Prince Albert, Swift Current, North Battleford and Buffalo Narrows.

The public can access air quality information for the six monitored sites, in real-time, on the Saskatchewan Ministry of Environment's website (environment.gov.sk.ca/airqualityindex). It is anticipated that additional sites will come online as future permanent monitoring sites are initiated in both urban centres and regional air zones of the province. Saskatchewan also receives and analyzes data from the federal government on the amount of pollutants released by major industry sectors through the National Pollutant Release Inventory program (NPRI, 2013).

To spot check and measure ambient air quality in locations outside the six sites with continuous monitoring, the Ministry of Environment operates a vehicle known as the Saskatchewan Air Monitoring Laboratory (SAML) equipped to monitor a variety of air pollutants. In 2012 until the end of June 2013, the SAML was used to conduct an extensive air quality monitoring survey in the City of Regina and surrounding area. The purpose of the survey was to proactively identify and quantify possible pollutants before they become a problem. Results were published and made available to the public on the ministry's website (refer to Local Snapshots at the end of this chapter for more information).

In 2014, the SAML was deployed in Saskatoon to conduct a similar study as was performed in Regina. The study will continue in 2015 with the results published and made available for the public on the ministry's website.

Provinces in Canada are making the transition to the Air Quality Health Index (AQHI), which has a greater focus on human health. The ministry will be making the transition to an hourly AQHI in 2015 but will continue to use the annual AQI, as it is a better overall long-term performance measure of the state of the environment.

Air monitoring system called an airpointer – The Ministry of Environment has one in North Battleford, Southeast Saskatchewan Airshed Association (SESAA) has seven and WYAMZ has four. This one is located near the Town of Unity.

1.2 Stressor Indicator: Air Pollutant Volume

Why is this indicator important?

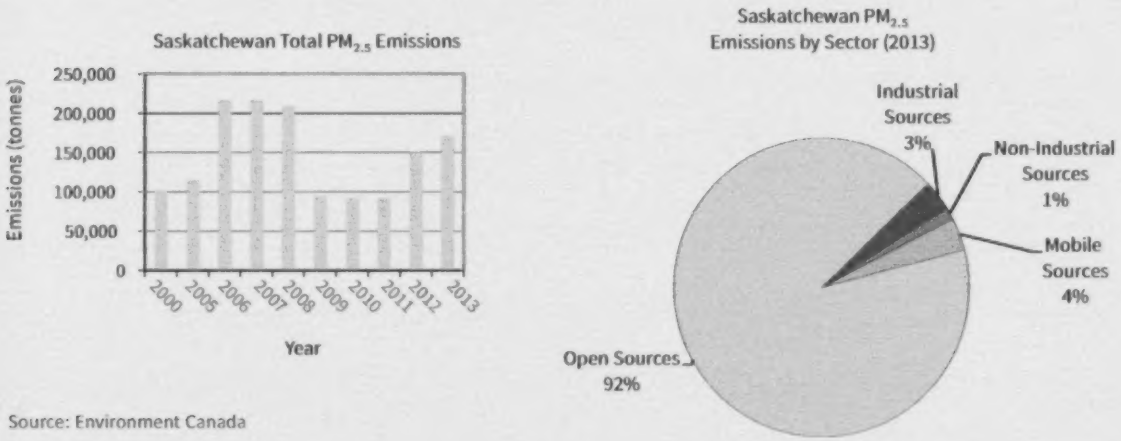
This indicator shows the total amounts (tonnes per year) of major air pollutants released annually in Saskatchewan. Levels of specific air pollutants are reported either as Criteria Air Contaminants (CACs) or non-CACs (Environment Canada, 2014). CACs are a group of air pollutants that affect human health and contribute to air pollution problems such as smog, acid rain and poor air quality. They include particulate matter of varying sizes, sulphur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), ground level ozone (O_3), and volatile organic compounds (VOCs). In most cases, they are the products of burning fossil fuels or industrial processes.

What does this indicator show?

Annual levels of three major CACs, as reported by the National Pollutant Release Inventory (NPRI 2014), accompanied by a breakdown of pollutants by emission source for 2012 are presented in Figures 1.2, 1.3 and 1.4. Emission sources and major contributing sectors include industrial (oil and gas and mining industries), non-industrial (electricity and fuel combustion), mobile (transportation), open (agriculture, waste and road dust) and natural (forest fires). A further definition of emission source terms are found in the report glossary (Page 87). CAC levels have remained relatively constant over the reporting period. Exceptions are particulate matter increases in 2006 to 2008 and in 2012 (Figure 1.2), mainly due to above normal forest fire activity in Saskatchewan and other parts of the country.

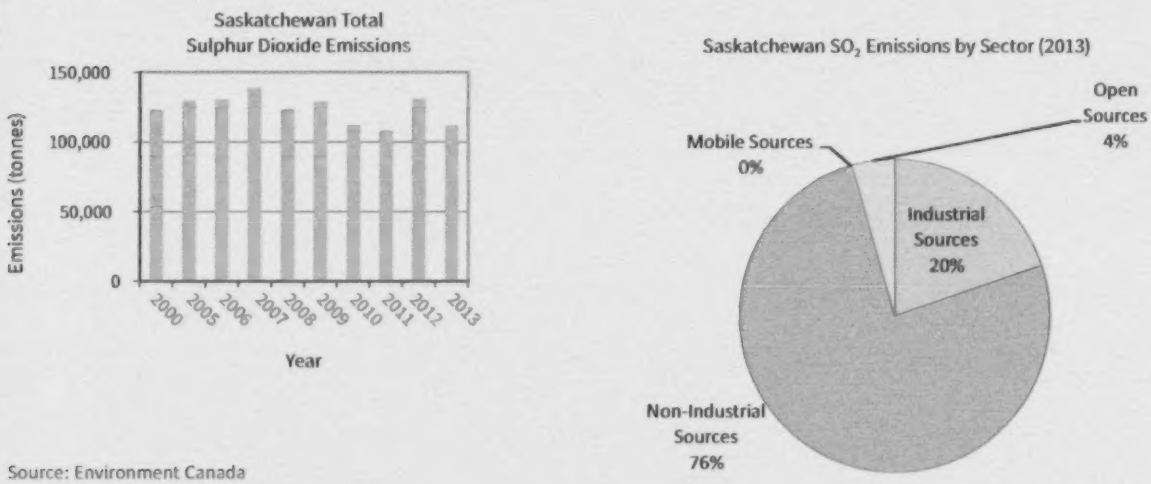
Overall, releases of air pollutants in Saskatchewan are low compared to other provinces (Environment Canada, 2000). For example, in comparing Saskatchewan with Alberta, Alberta's CAC releases have been over two times higher than Saskatchewan for particulate matter ($PM_{2.5}$), around three times higher for sulfur oxides (SOx), and five times higher for nitrogen oxides (NO_x) (NPRI, 2014).

Figure 1.2 Particulate Matter ($PM_{2.5}$ microns) Emissions in Saskatchewan



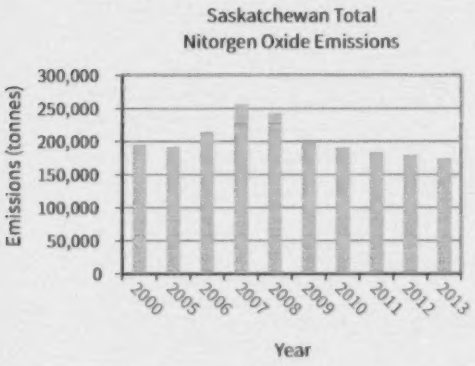
Source: Environment Canada

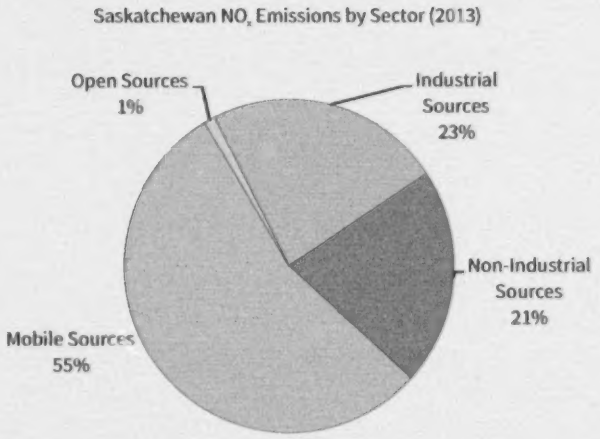
Figure 1.3 Sulphur Dioxide Emissions in Saskatchewan



Source: Environment Canada

Figure 1.4 Nitrogen Oxide Emissions in Saskatchewan





Source: Environment Canada

What actions are being taken?

The Ministry of Environment continues to collaborate with Environment Canada and supports the National Pollutant Release Inventory program that collects, stores and distributes annual air emissions data from all of the reporting sources in Saskatchewan and other Canadian jurisdictions. Saskatchewan is a member of the national Emissions Working Group whose mandate is to advise on the compilation and reporting of national inventories, trends, and projections for air pollutants of concern. The province reports particulate matter and ozone levels on a five-year basis to the Canadian Council of Ministers of the Environment (CCME, 2010). The levels in Saskatchewan for particulate matter and ozone are below the Canada-wide Standard (CWS). CCME reports annual particulate matter and ozone summaries online at:

ccme.ca/files/Resources/air/pm_ozone/PN_1526_2012_CWS_for_PM_and_Ozone_Final_Report.pdf

Saskatchewan has a wide range of regulatory tools to ensure activities in the province minimize air quality impacts. *The Clean Air Act, 1989* (with subsequent amendments), the development of modern legislation, *The Environmental Management and Protection Act (EMPA) 2010* and the Environmental Code all demonstrate the government's commitment to a healthy environment along with continuous improvements to maintain clean air in the province.

The legislation applies to any facility, operation, activity or equipment that is a source or potential source of an air contaminant in Saskatchewan. The Ministry of Environment currently issues clean air permits that contain conditions and requirements such as monitoring, modeling, reporting and complianceto operators of industrial sources, incinerators and fuel burning equipment in the province. The ministry continues to work with larger and more complex operations to maintain good air quality through the issuance of permits to operate. Once the Environmental Code becomes effective on June 1, 2015, industrial sources will not be required to obtain permits to operate, but instead will be required to submit environmental protection plans to the ministry for approval.

The ministry is also improving regulation for simpler operations through research and implementation of effective new tools. These tools include policies, codes of practice, industry association requirements, and the development of a results-based regulatory model and the Saskatchewan Environmental Code (Saskatchewan Ministry of Environment, 2009).

The Ministry of Environment monitors operational performance through compliance inspections of regulated activities, review of compliance reports, investigation of infractions, and enforcement when warranted. Industry continues to operate and make improvements to ensure their air quality meets Saskatchewan's Ambient Air Quality Standards, minimizing the adverse impact on human and ecosystem health.

As part of the provincial precipitation collection program, precipitation has been sampled at seven locations on a weekly basis since 2011. Atmospheric chemical deposition in Saskatchewan is being assessed to understand the monthly variations and the relative importance of sulfuric and nitric acids to precipitation acidity across the province. The main objectives of the program are to monitor changes and trends in the quality of precipitation in Saskatchewan and to determine the effects of wet deposition of chemical composition on the environment. Samples have been analyzed for sulfate, nitrate, chloride, ortho phosphate, calcium, magnesium, potassium, sodium and ammonia. Results for pH, specific conductivity, total acidity, strong acidity specific conductance and ion ratio were also collected and analyzed. Results to date do not indicate any adverse effects of acidic precipitation based on the pH and potential acid input levels. Monitoring will continue to obtain an enhanced understanding of long-term precipitation trends and the sulphur dioxide associated impacts to Saskatchewan' s northern and sensitive ecosystem due to regional and long-range industrial activity.

1.3 Response Indicator: Air Zone Management

Why is this indicator important?

The maintenance and expansion of air zones in the province demonstrates the ministry's progress towards innovative models of air pollutant management that best protect human health and the environment. An air zone is a regional geographic area that shares similar air quality characteristics and challenges. Its boundaries are typically established by considering topographic features, meteorology, economic activities, pollution sources, political boundaries and common air quality issues.

What does this indicator show?

Air zones are a viable management strategy that provide improved communication of air quality to Saskatchewan residents living within its boundaries. It allows for a more focused, local approach to air quality management, shows in a timely fashion if the regional air quality meets provincial standards, and identifies 'hot spots'.

Currently, Saskatchewan has five air zones established:

- Southeast Saskatchewan Airshed Association (sesaa.ca)
- Western Yellowhead Air Management Zone (wyamz.ca)
- Great Plains Air Zone (gpaz.org)
- Boreal Air Zone
- Grasslands Air Zone

Air zones have public, industry, government and non-government members managed by an executive director and board of directors with committees for finance, science, communications and governance. Real-time air quality data and reports will be available on the air zones' websites. The work to establish a final air zone in the Prince Albert-Hudson Bay region is underway.

What actions are being taken?

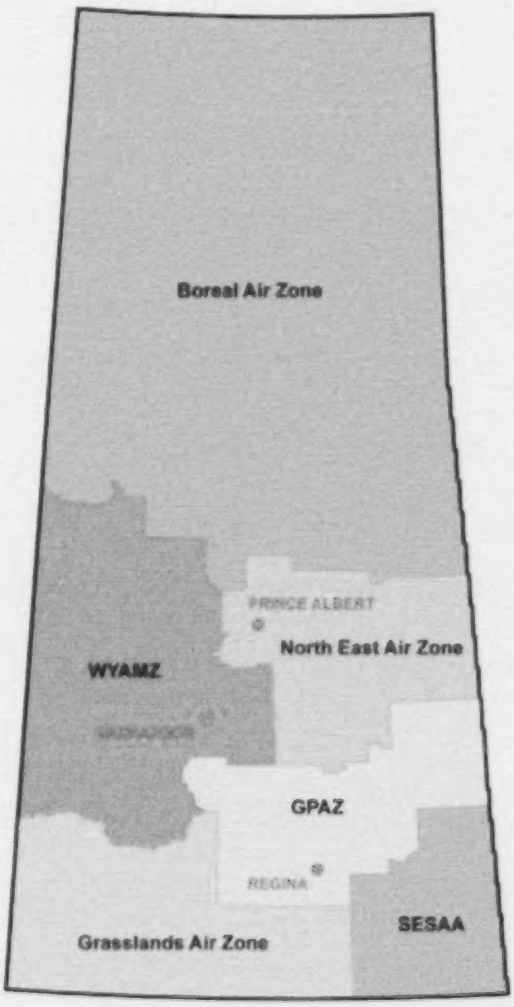
The Ministry of Environment's established air zones across the province are based on an air zone association model established in 2005, and will integrate with the new Canada-wide Air Quality Management System (AQMS). The AQMS has been developed by federal, provincial and territorial jurisdictions. The new comprehensive air management system is outcomes-based, defining the desired ambient air quality through setting Canadian Ambient Air Quality Standards (CAAQS) for fine particulate matter and ozone in 2013. CAAQS for sulphur dioxide and nitrogen oxide are in the process of being developed for completion in 2015. AQMS is a place-based system established within provinces and territories to ensure local needs and their unique circumstances are effectively addressed.

Saskatchewan continues to contribute to various aspects of AQMS including:

- establishment of base-level emission guidelines for industrial sectors such as electricity, potash, chemicals, steel production, pulp and paper, upstream oil and gas, oil sands and petroleum refining;
- review of the CAAQS that provide an enhanced level of protection for human health and the environment; and
- the creation of agreements on regulatory assurance and mechanisms for stakeholder engagement. Environmental non-government organizations have been invited to join working groups to help develop performance standards with industry and government representatives.

Air zone management fits with the ministry's new results-based regulatory model and Saskatchewan's new Environmental Code. Saskatchewan's air zone organizations will become valuable organizations that will monitor regional air quality. Air zone management can provide flexibility to consider regional differences while ensuring national consistency, managing issues associated with trans-boundary influences and providing a level playing field for industry.

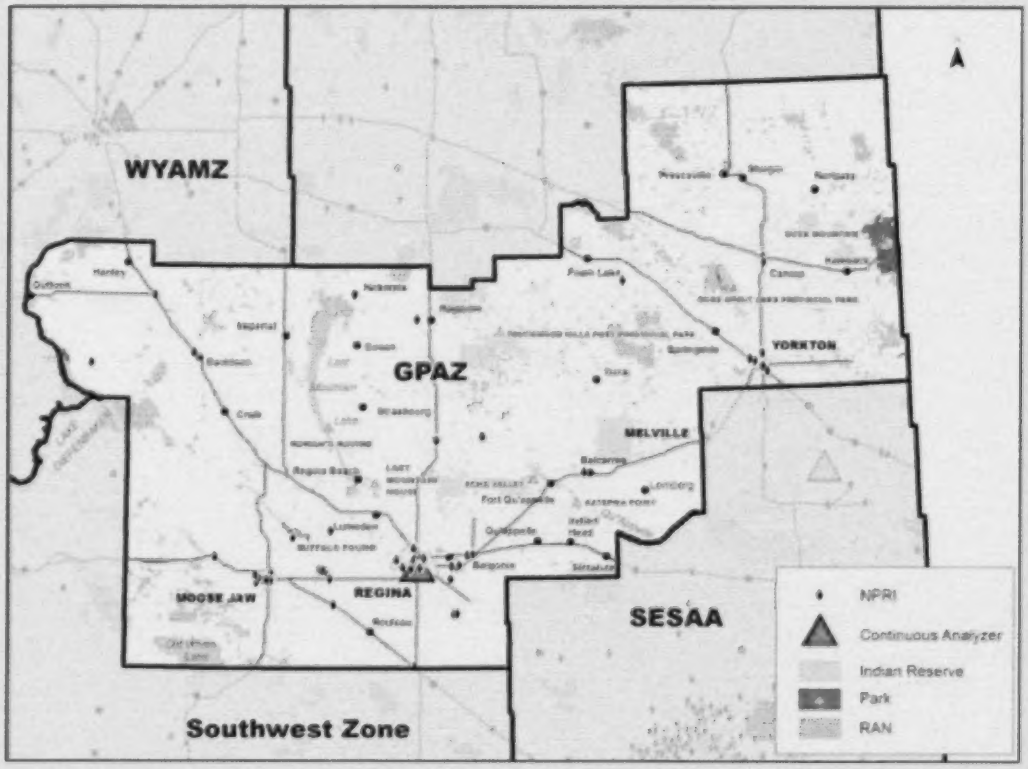
Saskatchewan Air Zones



WYAMZ - Western Yellowhead Air Management Zone
SESAA - Southeast Saskatchewan Airshed Association
GPAZ - Great Plains Air Zone

Saskatchewan's Third Air Management Zone

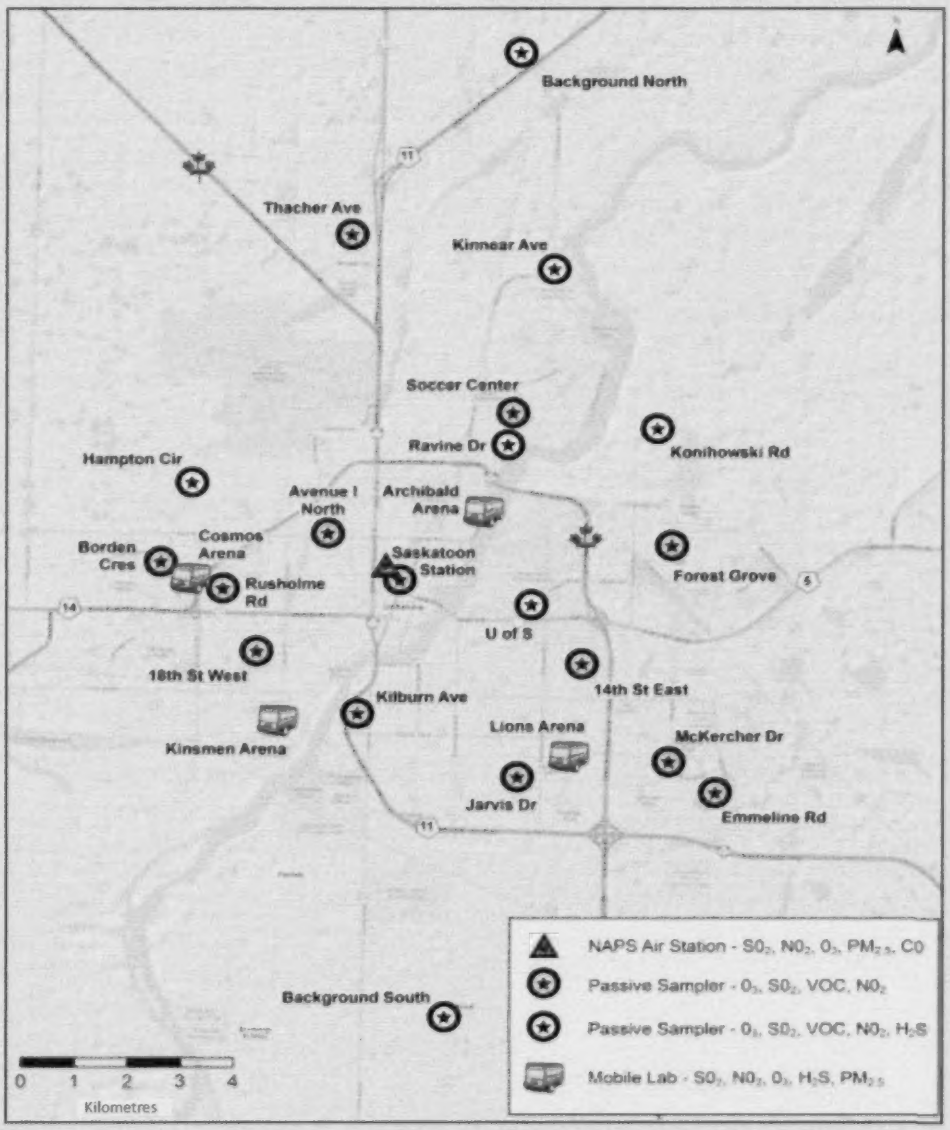
The Great Plains Air Zone (GPAZ) was formed in the fall of 2013 and is the third air management zone established in the southern and central region of the province. The GPAZ encompasses an area of approximately 40,000 square kilometres. Regional boundaries were established based on common history, meteorological conditions and funding considerations. Key economic activities in the region include agriculture, manufacturing, oil and gas refining, mining and transportation. The Great Plains Air Zone is a non-profit organization of public, industry, government and non-government members. The GPAZ will collect credible, continuous real-time air quality information through the collaborative efforts of industry, government, non-government and stakeholder representatives. Air quality data will be freely available to all stakeholders and will also be used to help manage and drive improvements to air quality in the air zone. Air monitoring data is currently being collected in Regina through a co-operative federal/provincial program that monitors air quality in most major cities in Canada. Proposed data collection in GPAZ may also include continuous monitors located in Moose Jaw and Yorkton.



Source: Saskatchewan Ministry of Environment, Technical Resources Branch

Saskatoon Air Quality Monitoring Study

To continue the vigilance of checking the status and trend of the province's air, a comprehensive air quality monitoring study for Saskatoon was initiated in 2014 in response to the success of the 2013 Regina Air Monitoring Study. The Ministry of Environment, along with the Ministry of Health, Saskatoon Health Region, Airways Research Group and the City of Saskatoon are trying to gain a better understanding of Saskatoon's air quality in the city's residential neighbourhoods by conducting an extensive air monitoring survey. This survey will: provide baseline data to compare with similar monitoring studies; proactively identify potential pollutant concerns before they become a problem; and assist with determining where additional permanent monitoring stations should be located. Different monitoring methods (see map) were used to collect monthly measurements at 20 sites for nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and more than 25 different volatile organic compounds (VOCs). The Saskatchewan Air Monitoring Laboratory (SAML) was also deployed to collect real-time data at four different sites in the city on a scheduled rotation for particulate matter ($PM_{2.5}$), NO_2, O_3, SO_2 and H_2S. The monitoring program will be completed during the summer of 2015. The final results will be published and made available to the public on the Ministry of Environment's website.



Source: Saskatchewan Ministry of Environment, Technical Resources Branch

The Saskatchewan Air Monitoring Lab

The Saskatchewan Air Monitoring Lab (SAML) is a vehicle designed to measure air quality and is equipped to continuously monitor a variety of air pollutants simultaneously. The convenience of a mobile lab allows the Ministry of Environment to monitor ambient air quality anywhere in the province that is accessible by road.

The purpose of the SAML is to enhance the collection of air quality data by sampling a broader range of sites, to better locate sites for permanent air quality monitoring stations and to conduct special surveys at locations where air quality is a concern. However, it can also be deployed in emergency situations and in response to incidents that impact public health and safety, where air quality is a concern.

In addition to being able to measure wind direction and speed, temperature, solar radiation and relative humidity, the SAML is equipped to measure sulphur dioxide, carbon monoxide, ozone, nitrogen oxides, fine and course particulates, hydrogen sulphide, ammonia, total hydrocarbons and volatile organic compounds.

Highlights for Air

Overall, Saskatchewan's air quality meets Saskatchewan's Ambient Air Quality Standards and shows pollutant levels, which are reported continuously online by the ministry, as being relatively low . Saskatchewan currently has five established air zone associations that have been set up to monitor regional air quality, with the last zone in the planning stages.

The following is a summary of the status and trend of the three air indicators reported on in this chapter:

1.1 **Air Pollutant Concentration** – The Air Quality Index (AQI) data shows positive environmental conditions, in that air quality is primarily excellent, with no significant change in the value of the indicator.

1.2 **Air Pollutant Volume** – Air pollutants have remained relatively constant over the reporting period with no significant change in the value of the indicator.

1.3 **Air Zone Management** – The status of this response indicator is positive as there are now five air zone associations in the province compared to two associations that were highlighted in the *2013 State of the Environment Report*. The first two established air zones have set up a combined total of 12 continuous air monitoring stations that continuously report online air quality data and the calculated AQI.

climate

Key Points

- The province is working with industry and other stakeholders to reduce greenhouse gas (GHG) emissions through new results-based regulations, and establishment of the policy and regulatory framework for the provincial climate change program.
- Saskatchewan's GHG emission intensity is decreasing due to investments in low-carbon technologies and energy productivity improvements.
- GHG emission intensity decreased by eight per cent, while GDP grew by 16 per cent during the 2006 to 2012 period, through decoupling of GHG emissions from economic growth.

Introduction

Climate change is a statistically significant change in the distribution of global weather patterns when that change lasts for an extended period of time. Climate change is one of the main challenges facing governments, communities and industry because it poses significant threats to environmental sustainability, economic growth, biodiversity, human health, infrastructure and water resource management.

Climate change has become a global issue of growing importance. Economic sectors that rely heavily on climatic factors for production (e.g. agriculture and forestry) may see change due to a longer, warmer growing season with the potential for increased productivity. This potential productivity could be limited by available soil moisture or an increase in disease and insect damage. Increasing climate variability, potentially resulting in flooding and drought events, poses challenges in terms of water supply management and demand for improved cross-government planning, flood damage prevention infrastructure and flow forecasting. Growing provincial populations will increase demand for food, water and energy, all of which may be impacted by climate variability.

Indicators for Climate

Stressor

2.1 Greenhouse Gas Emissions — examines the trends in total GHGs in Saskatchewan, as well as the emissions by sector. It also compares changes in GHG emission intensity and Saskatchewan's Gross Domestic Product (GDP).

Impacts of Climate Change in Saskatchewan

Carbon dioxide is the major GHG produced by human activities in Saskatchewan, constituting 61 per cent of total 2012 emissions. Other major GHG sources include methane (25 per cent), nitrous oxide (13 per cent) and fluorinated gases (one per cent).

Significant overall increases in precipitation and mean annual temperatures are predicted to occur during the 2015 to 2100 period.

Projected changes in precipitation and temperature will have both positive and negative consequences for agricultural productivity. Projected increases in winter and spring precipitation are expected to benefit agricultural productivity by increasing water availability through soil moisture reserves during the early growing season, but this can be offset by fields too wet to plant.

Rising temperatures will lengthen the growing season. Warmer winters pose challenges. For example, some pests and invasive weeds will be able to survive the warmer winters. Rainfall events already have become more intense, increasing erosion and nutrient runoff, and projections are that the frequency and severity of these heavy rainfall events will increase.

Saskatchewan will remain vulnerable to periodic drought because much of the projected increase in precipitation is expected to occur in the cooler months, while increasing temperatures will result in additional evapotranspiration - which is the sum of evaporation and plant transpiration from the earth's land and ocean surface to the atmosphere.

Changes to crop growth cycles due to warming winters and alterations in the timing and magnitude of rainfall events have already been observed; as these trends continue, they will require new agriculture and livestock management practices. Communities that are already vulnerable to weather and climate extremes could be stressed even further by more frequent extreme events occurring within an already highly-variable climate system.

Changes in Saskatchewan's climate are expected to have impacts on our natural resources, and the industries dependent on them. Saskatchewan potentially faces major climate change effects on ecosystems and landscapes. Drier growing seasons will be an important ecosystem impact and can present a challenge to the conservation of fish, wildlife and biodiversity. Landscape fragmentation is also increasing in part from energy development and mining activities. A more fragmented landscape adds to the challenges species face when climate change alters habitat composition and timing of plant development cycles.

Due to their northern location, Saskatchewan's forests are exposed to greater increases in temperature than the global average. Increases in disturbance regimes such as forest fires, and pest and disease outbreaks are already evident and are expected to become more pronounced in the future. Over the long term, forest composition (biodiversity of ecosystem) will change in some areas due to shifting climatic and disturbance regimes.

Forest productivity could be positively impacted in some regions of the province by warmer temperatures, longer growing seasons and increasing CO_2 levels, but also could be negatively impacted by increased drought and more frequent and severe disturbances and extreme weather events.

2.1 Stressor Indicator: Greenhouse Gas Emissions

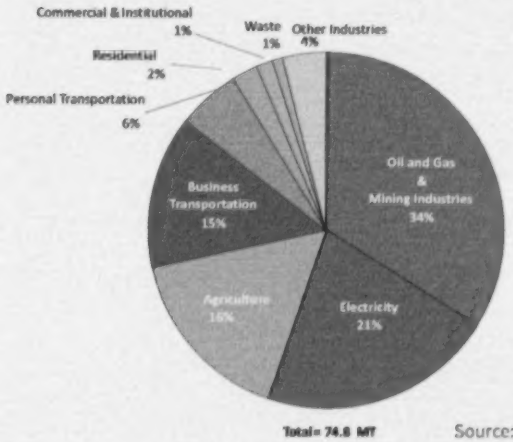
The level of GHG emissions is an indicator of human activity affecting the global atmosphere and causing most of the increase in global temperatures. GHGs include mainly carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and water vapour.

Saskatchewan's GHG emissions, which totaled 74.8 million tonnes in 2012, account for about 11 per cent of Canada's annual GHG emissions of 699 million tonnes. Canada produces about 1.4 per cent of total global GHG emissions (World Resources Institute). Saskatchewan's land base includes extensive natural landscapes such as forests, wetlands and grasslands, and also supports agricultural ecosystems that capture and store carbon from the atmosphere.

What does this indicator show?

The main provincial sources of GHGs are shown in Figure 2.1 (Canada-National Inventory Report, 1990–2012). The oil and gas industry (34 per cent) and electricity generation (21 per cent) account for more than half of the province's GHG emissions. Transportation (21 per cent) and agriculture (16 per cent) are other large sources of GHG emissions.

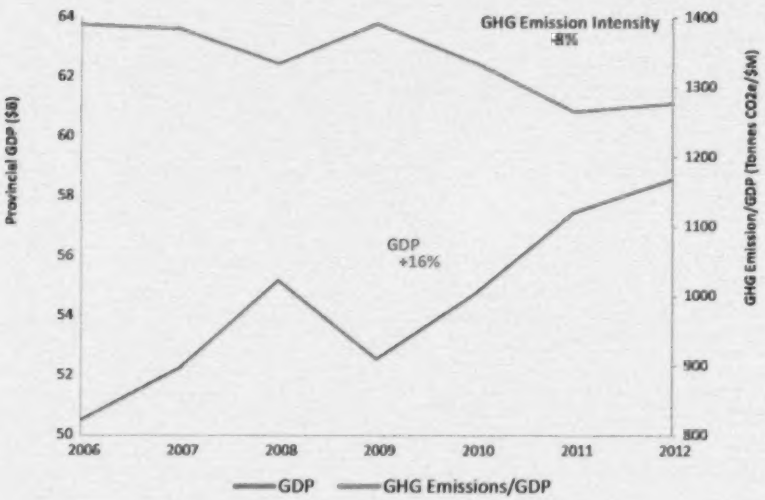
Figure 2.1 Saskatchewan GHG Emissions by Sector, 2012



Source: Environment Canada - NIR 1990 - 2012

Provincial GHG emissions have stabilized since 2008, despite strong economic and population growth. Investments in low-carbon technologies in excess of $5 billion have contributed to slowing emission growth. Energy efficiency improvements and technological innovation reduced the intensity of GHG emissions by eight per cent during the 2006–2012 period, while provincial GDP increased by 16 per cent during the same period (see Figure 2.2). This represented a decline of six per cent in GHG emission intensity per billion dollars of GDP growth.

Figure 2.2 The Intensity of Saskatchewan GHG Emissions (2006-2012)

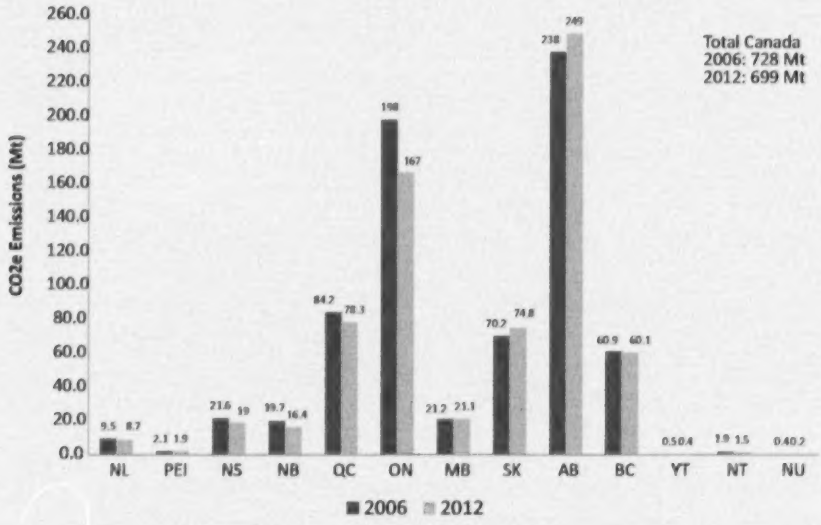


Source: Stats Canada, NIR 1990 - 2012

Declining emission intensity has occurred due to internal efficiencies from energy conservation and efficiency, and industry investments in low-carbon technologies. There is evidence to suggest that Saskatchewan's economic growth is becoming decoupled or delinked from GHG emission growth. Decoupling of GHG emissions from economic growth is critical for mitigating climate change impacts, while supporting sustained growth in key sectors such as coal-fired electricity generation, oil and gas and mining.

Saskatchewan is showing leadership in balancing economic growth with environmental outcomes. GHG emissions and their impact upon climate change is a part of a larger economic relationship where oil production and economic growth were linked.

Figure 2.3 Saskatchewan's GHG Emissions Have Increased Modestly with Strong Economic Growth



Source: Environment Canada, NIR 1990 - 2012

Saskatchewan's GHG emissions have increased by 4.6 million tonnes, or 6.6 per cent, since 2006, due to strong economic and population growth (per Figure 2.3). Increased oil and gas production and potash mining activity, and growing transportation emissions associated with motor vehicle use and export shipments accounted for most of the growth in GHG emissions.

What actions are being taken?

The provincial climate change program will promote emission reductions in all sectors of the economy through the regulation of large emitters, and policy measures and incentives in non-regulated sectors. *The Management and Reduction of Greenhouse Gases Act* was passed in May 2010, establishing the framework for GHG reductions by balancing environmental protection with economic growth.

The GHG legislation was amended in April 2013 to enable an equivalency agreement to be negotiated with the federal government under the provisions of the *Canadian Environmental Protection Act*. Negotiation of a Canada/Saskatchewan equivalency agreement could provide flexibility for regulated emitters to meet their compliance obligations, while achieving equal or better environmental outcomes than the federal coal-fired electricity regulatory framework.

The climate change program will maintain industry competitiveness by promoting the use of best available GHG abatement technologies to reduce GHG emissions, while containing increases in the capital and operating costs of different facilities and sectors.

The Ministry of Environment is developing a single window GHG reporting system in partnership with the federal government to standardize the measurement, reporting and verification of GHG emissions.

Reporting of GHG emissions and other climate change data can assist decision-makers. Measuring progress in reducing GHG emissions can contribute to sustainable economic growth by managing the risks and opportunities from climate change more effectively. New GHG quantification and reporting methods are being developed to complement standard accounting practices. Streamlining of reporting requirements could contribute to meeting key sustainability challenges such as reducing GHG emissions and energy usage, and enhancing the performance outcomes of environmental initiatives.

The Go Green Fund has supported research and demonstration projects and technological innovation, including low-carbon technologies and processes that reduce GHG emissions, in different sectors of the economy. The Go Green Fund provided $60 million in funding support to more than 60 projects to demonstrate new environmental technologies and processes during the 2008-09 to 2014-15 period.

Major projects supported by the Go Green Fund included:

- Aquistore carbon storage project, in partnership with the Petroleum Technology Research Centre and SaskPower;
- High level wind energy storage project, in partnership with Cowessess First Nation and the Saskatchewan Research Council;
- Landscape Connectivity and Focused Habitat Securement Project, in partnership with Environmental Systems Assessment Canada, the Saskatchewan Wildlife Federation and the Nature Conservancy of Canada;
- Wastewater treatment system for industrial water reuse, in partnership with Ground Effects Engineering (featured in the *2013 State of the Environment Report*);
- Wood biomass based district energy system and wood pellet manufacturing facility project, in partnership with the Meadow Lake Tribal Council (featured in the *2013 State of the Environment Report*);
- Net metering program to demonstrate the viability of small-scale renewable energy systems, including solar, wind and biomass administered by the Saskatchewan Research Council.

Other GHG Emission Reduction Initiatives

Saskatchewan is also committed to expanding the capacity of clean, renewable sources of energy such as wind, solar power and biomass, to meet electricity demand growth and reduce GHG emissions. For example, wind energy capacity is expected to increase to 375 MW by 2017, or eight per cent of SaskPower's electricity generation capacity, up from five per cent today. Biomass and other green power initiatives will add 92 MW of power generation capacity by 2017, or two per cent of SaskPower's electricity network.

SaskPower and SaskEnergy are pursuing energy efficiency and conservation measures to reduce energy usage by their customers, which will contribute to reducing provincial GHG emissions. SaskPower and SaskEnergy are pursuing energy efficiency and conservation measures to reduce energy usage by their customers, which will contribute to reducing provincial GHG emissions. SaskPower has also made a significant effort towards reducing greenhouse gas emissions with the development of the world's first and largest commercial-scale carbon capture and storage project at the Boundary Dam Power Station near Estevan. This project, which is able to capture 1,000,000 tonnes of CO_2 every year, demonstrates Saskatchewan's leadership in developing innovative, clean energy technology.

Saskatchewan is working with the oil and gas industry to reduce GHG emissions from flaring and venting activities, in partnership with the Canadian Association of Petroleum Producers (CAPP) and the Ministry of Economy. The oil industry generated about 25 million tonnes of GHG emissions in 2012, or 34 per cent of total provincial emissions.

The Ministry of Environment is also encouraging the development of GHG inventories in partnership with the Saskatchewan Urban Municipalities Association (SUMA), and the cities of Saskatoon and Regina, under the Federation of Canadian Municipalities' Partners for Climate Protection Program. Benchmarking of GHG emissions from community sources will enable GHG emissions to be measured and reported, and demonstrate best practices for reducing them in landfills, transportation systems, and other municipal operations.

Photo Credit: Ground Effects (GGF Symposium)

ElectroPure Frac Flowback Water Treatment System

The industrial sector, including the oil and gas and potash industries, is the third largest user of water in Saskatchewan. In many instances, treated or fresh water is used in industrial applications where the water is not required to be of high quality. The flowback water system demonstration project tested a technology to treat wastewater to a quality that is sufficient for industrial reuse, which would ultimately lead to the reduction in the amount of fresh water used by industry.

The Go Green Fund provided funding to Ground Effects Environmental Services Inc. to apply the ElectroPure Technology (EPT) to treat industrial wastewater. The EPT technology has the ability to efficiently remove a wide range of contaminants simultaneously including colloidal solids, break emulsions, hydrocarbons, complex organics, bacteria, viruses and cysts. Ground Effects Engineering has taken steps to further optimize the technology, dramatically increasing removal rates, while decreasing capital and operating costs. Through the development of unique multi-plate geometries, as well as the development of a proprietary treatment train, this process has the potential to remove up to 99 per cent of contaminants.

Laboratory testing began by determining various parameters that would be optimal for the EPT technology to treat the waste water located at a large industrial client. A continuous field demonstration was completed using the modified EPT system to treat more than 1,270 cubic metres of water during the demonstration project.

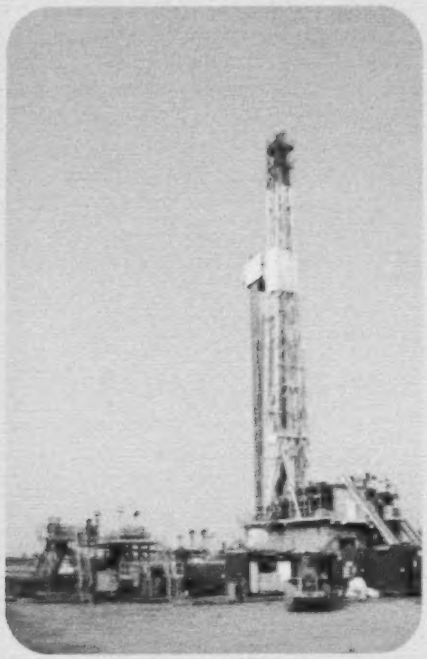


Photo Credit: Aquistore (GGF Symposium)

AQUISTORE: Saskatchewan's Deep Saline $C0_2$ Storage Research Project

Aquistore is an independent research and monitoring project near the Boundary Dam power plant site managed by the Petroleum Technology Research Centre (PTRC) and supported by industry and government. The Go Green Fund provided $5 million over four years to assist PTRC in developing the monitoring system to test the permanent storage of CO_2 in a deep geological formation. The main objective of the Aquistore project is to demonstrate that carbon dioxide (CO_2) storage in saline aquifers is a safe and effective solution for reducing industrial greenhouse gas emissions. Injection of carbon dioxide in the Aquistore disposal well is expected to begin in 2015, with up to 2,000 tonnes per day of CO_2 emissions from the Boundary Dam carbon capture and storage project being stored at the site. The results of the Aquistore demonstration project will be disseminated by PTRC and SaskPower to interested utilities, industries, research institutions, governments, environmental organizations, and the general public to advance carbon storage projects in other jurisdictions.

Cowessess High Level Wind Turbine and Storage System

The Go Green Fund provided $1.4 million to the Saskatchewan Research Council to demonstrate the viability of a 73-metre-high level wind turbine combined with a battery storage system to reduce the volatility and variability of wind generation, in partnership with Cowessess First Nation. The 800 kW wind turbine provided electricity to the SaskPower grid at peak periods by dispatching power stored in the battery system. The project demonstrated the durability of wind-battery systems, and the role of smart grid capabilities and renewable energy sources in reducing GHG emissions. The project showed that wind energy can be reliably dispatched at peak times with a durable battery system. Deployment of wind turbines with advanced battery storage systems could facilitate increased usage of wind energy for load following by SaskPower, and delay the requirement for electricity transmission and distribution line upgrades.

Photo Credit: SRC and Cowessess First Nation

Highlights for Climate

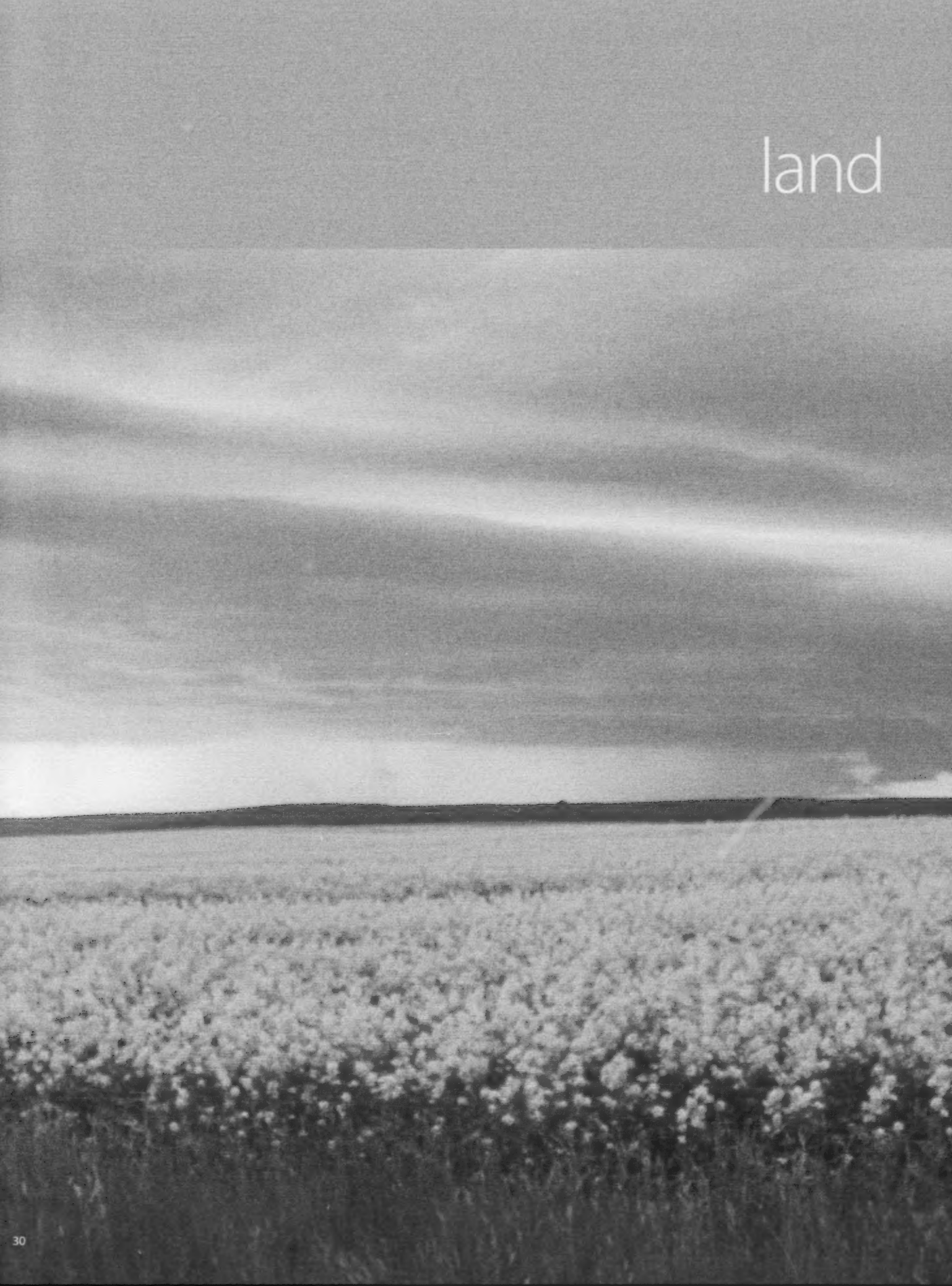
Saskatchewan's GHG emissions stabilized between 2008 and 2012 despite strong economic and population growth (see Figure 2.2).

Increased oil and gas production and potash mining activity, and growing transportation emissions associated with motor vehicle use and export shipments accounted for moderate growth in GHG emissions in recent years. The Government of Saskatchewan is addressing this through results-based legislation and investment in innovative technology and solutions.

The status of the climate change indicator reported in this chapter is summarized as follows:

1.1 **Greenhouse gas emissions** – Saskatchewan's GHG emissions have increased by 4.6 million tonnes, or 6.6 per cent, since 2006, along with the growing economy. In recent years, provincial GHG emissions slowed with modest growth of 1.6 per cent in GHG emissions between 2008 and 2012. Saskatchewan has reduced its intensity of GHG emissions by 8 per cent during the 2006-2012 period.

land



Key Points

- Improvements in agricultural practices, such as reduced summerfallow and increasing zero-till, are improving the environmental health of agricultural lands.
- Potential pressure on land from industrial developments is increasing.
- Industry and government are continuously improving their environmental management practices.
- Waste recycling efforts are increasing, reducing the pressure on land.

Saskatchewan has an abundance of land, space and natural resources. From cattle ranching and farming on the southern prairies to hard rock mining on the northern shield, land use in Saskatchewan is varied. From this abundance, economic opportunities develop that benefit all citizens of the province and it is anticipated that these opportunities will continue into the future *(2013 State of the Environment)*.

Ecosystems, and the services that they provide, impact the province's ecological, socio-cultural and economic well-being (de Groot, et al 2010). The government is required to make frequent decisions on how best to manage and allocate land use within Saskatchewan. Land use planning is an ecosystem-based tool that can link the environment, the community and the economy in ways that help ensure the sustainability of resources. Federal, provincial and municipal levels of government share responsibility for approving and managing activity across the landscape. In Saskatchewan, the primary responsibility for managing community planning, development issues, land use and municipal services rests with the local municipalities. The Ministry of Environment has been proactive in working with stakeholders to ensure a balanced approach to addressing the economic pressures of growth with environmental protection. Issues such as native prairie conversion, the intensity of agriculture on the landscape, and industrial exploration and development are at the forefront of the ministry's continued vigilance in its monitoring and measurement of the changes to our land.

Indicators for Land

Condition

3.1 Agricultural Land Cover – tracks trends in land cover and management practices over time and serves as a proxy for agri-environmental health.

Stressor

3.2 Mineral Disposition Activity – provides an indication of interest in Saskatchewan's mineral resources and possible future expansion of industrial activity.

Response

3.3 Area Under Zero-Till – tracks changes in the area of farmland in Saskatchewan under zero-till and other forms of tillage.

3.4 Private Land Stewardship – tracks conservation trends in the agricultural landscape. In addition to conservation actions by landowners, complementary government actions are reported on for maintaining healthy ecosystems.

3.5 Waste Recycling – tracks trends in the proportion of materials recycled in Saskatchewan.

3.1 Condition Indicator: Agricultural Land Cover

Why is this indicator important?

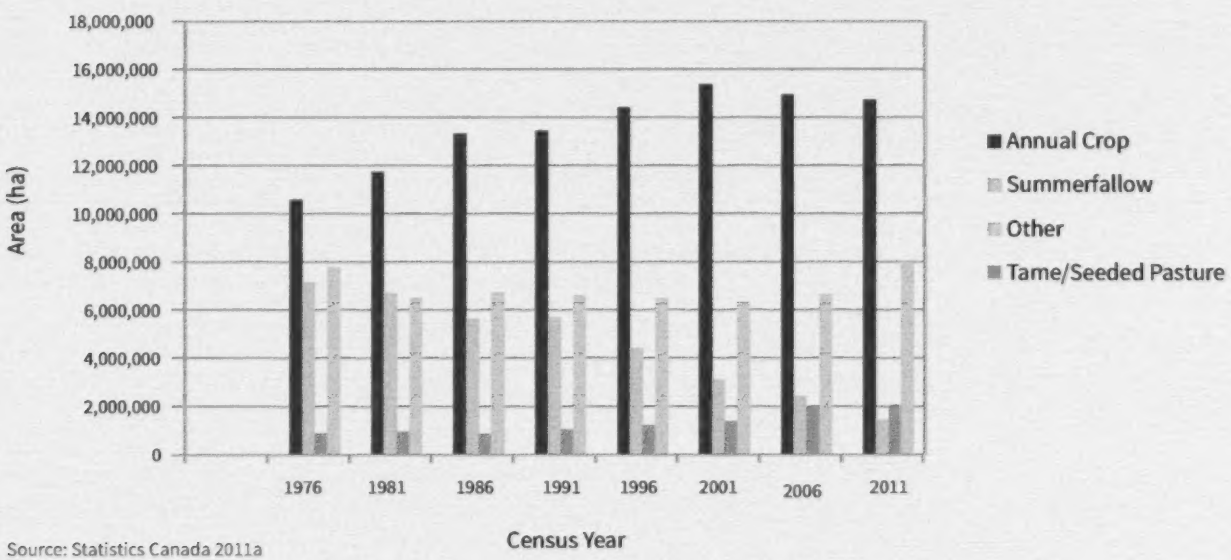
Just as the diversity in forest types reflects forest landscape biodiversity, so do the land cover types in the agricultural areas of Saskatchewan. In general, agro-ecosystem land cover types like annual crops, summerfallow, and tame or seeded pasture support lower levels of native biodiversity than do natural areas like native grasslands, wetlands and woodlands. This is not surprising as the main intent of farming is food or forage production. Examining the status and trends of agricultural land cover and management practices over time provides the ability to track whether the trend is either towards or further away from enhancing biodiversity *(2013 State of the Environment)*.

What does this indicator show?

Figure 3.1 shows the area of cropland, summerfallow, tame/seeded pasture and other land types in Saskatchewan from 1976 to 2011 (Statistics Canada, 2011a). "Other land" types include natural land for pasture and other land including woodlots, marshes and yards[1]. This information is taken from the 2011 Census of Agriculture, and - because the frequency is every five years - represents the most recent measure of the overall state of Saskatchewan agriculture and its wealth of data provides a valuable snapshot of the sector.

The amount of farmland devoted to annual cropping has steadily grown through the reporting period, along with a significant decline in summerfallow. The area devoted to tame or seeded pasture has more than doubled from 1986 to 2011 (878,726 hectares compared to 2,057,957 hectares respectively), while the area in the category of "other land" has remained relatively constant since 1986. The exception is the increase in the "other land" category for 2011. This increase is due to land reported as "too wet to seed" and has been classified as "other land" instead of cropland or summerfallow (Statistics Canada, 2011a).

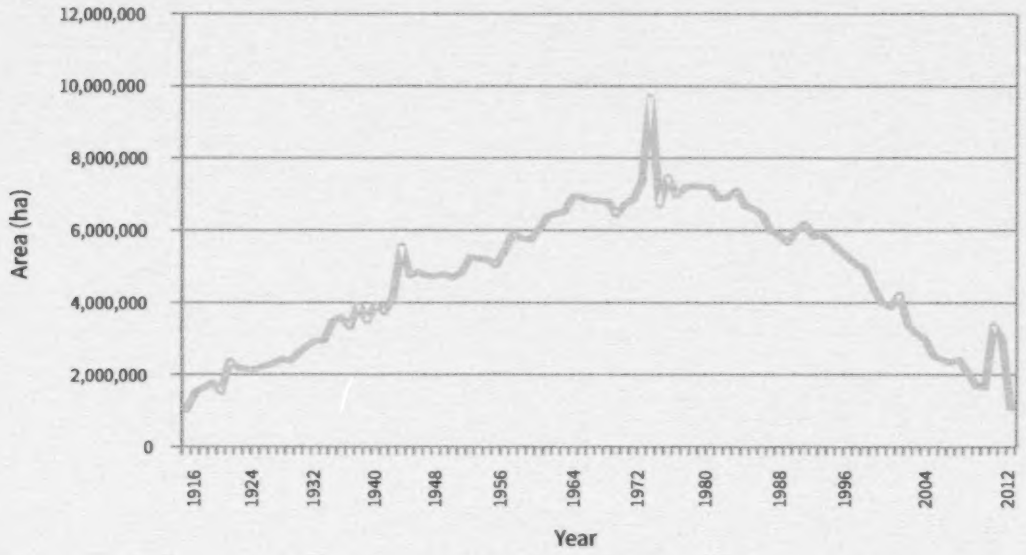
Figure 3.1 Land Cover Type on Saskatchewan Farmland, 1976 to 2011



Source: Statistics Canada 2011a

[1]Saskatchewan experienced flooding in the spring and summer of 2011 and land reported to the 2011 Canadian Census of Agriculture as "too wet to seed" has been categorized as "other land" and not cropland or summerfallow. This land could shift back to cropland when conditions improve. Saskatchewan reports land "too wet to seed" as summerfallow.

Figure 3.2 Area of Land Under Summerfallow in Saskatchewan, 1916 to 2012



Note: The increase in summerfallow hectares in 2010 and 2011 is due to abnormally wet growing seasons that resulted in land that couldn't be seeded because of excess water, and is reported by the Ministry of Agriculture as summerfallow (refer to Footnote[1] for difference in reporting by Statistics Canada).

Source: Saskatchewan Ministry of Agriculture, 2012

A closer examination shows changes in the area of summerfallow on Saskatchewan farmland from 1916 to 2012 (Figure 3.2) (Saskatchewan Ministry of Agriculture, 2012a). The area of farmland devoted to summerfallow steadily increased up to the 1960s and 1970s, and has declined ever since. In fact, according to Statistics Canada, summerfallow as a proportion of total farm area in Saskatchewan decreased to 5.8 per cent in 2011 from 9.3 per cent in 2006. Its decline is associated with the growing awareness of summerfallow's negative environmental effects such as soil erosion, soil organic depletion and increased soil salinity. It is estimated that up to 50 per cent of the soil's organic matter had been lost in Saskatchewan since cultivation began and before the uptake of more sustainable practices such as conservation tillage and zero-tillage (Saskatchewan Ministry of Agriculture 2011b).

What actions are being taken?

Farmers in Saskatchewan are broadly adopting alternatives to summerfallow, such as zero-till. The organic matter of Saskatchewan's farmland soils is now being actively restored (West and Post 2002), resulting in higher levels of agri-environmental health. Various permanent cover programs have also contributed to some cropland being re-seeded back to grass. The Ministry of Environment continues to successfully address the pressures on natural areas like wetlands, woodlands, and native grasslands and are supportive of collaborative conservation efforts like the Prairie Conservation Action Plan (PCAP, 2010) *(State of the Environment, 2013)*.

3.2 Stressor Indicator: Mineral Disposition Activity

Why is this indicator important?

The development of Saskatchewan's non-renewable resources continues to be critical to its future growth and economic well-being and the province is a leader in the Canadian and global mining scene. Saskatchewan has more than 25 operating mines that produce potash, uranium, gold, coal, salt, meta-kaolin, silica sand, sodium and potassium sulphate, clay and bentonite, in addition to developing resources such as diamonds, platinum, palladium, rare earth elements, copper, zinc and nickel.

Canada's mineral production was valued at $44 billion in 2013 with Saskatchewan as the third leading jurisdiction accounting for 16.4 per cent of Canada's mineral output (Saskatchewan Mining Association, 2014).

Provincial mineral sales in 2013 were $7.14 billion (down marginally from $7.4 billion in 2012, and $8.1 billion in 2011, but up from $6.86 billion in 2010 and $4.6 billion in 2009. In its 2013-2014 Survey of Mining Companies, the Fraser Institute ranked Saskatchewan second in Canada, and fourth out of 112 mining jurisdictions around the world for mineral potential assuming current regulatory and policy environments *(Ministry of the Economy, 2014)*.

Mining is therefore a major contributor to Saskatchewan's economy, with exploration expenditures totaling just over $297 million. Mining directly contributed more than $1.5 billion in revenue in 2013 to the provincial government and created direct and indirect employment for approximately 30,500 people.

Other important industrial activities in the province include forestry, oil and natural gas. The key to the management of these economic activities is corporate social and environmental responsibility coupled with effective government environmental controls.

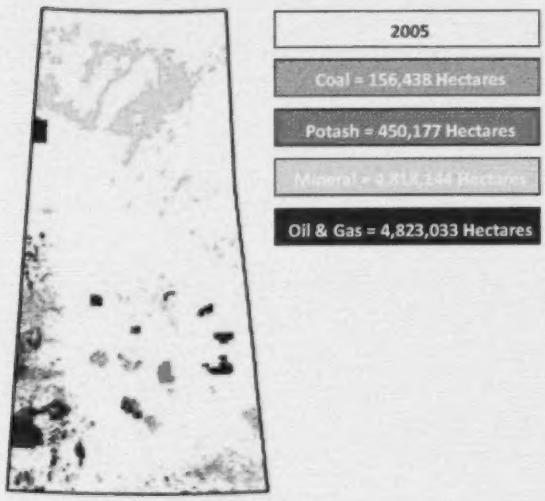
What does this indicator show?

Figures 3.3, 3.4 and 3.5 illustrate the geographic growth of industrial activity between 2005 and 2014 in Saskatchewan as reflected by the sale of sub-surface mineral leases *(Saskatchewan Ministry of Economy, 2014)*.

Figure 3.6 shows the value of these Crown land sales for mineral exploration and development (not including surface lands) from 1968 to 2013 *(Saskatchewan Ministry of the Economy, 2015)*.

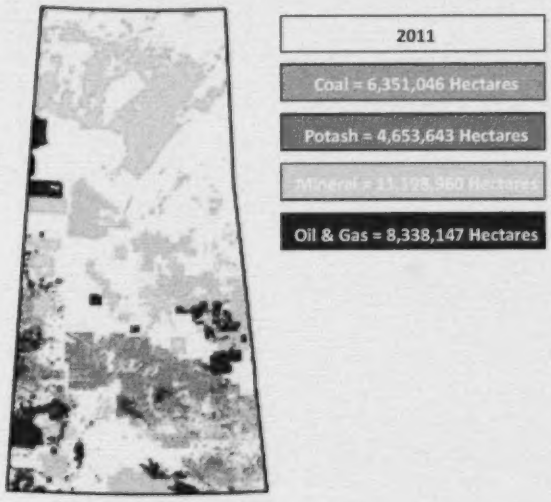
The disposition of minerals is an indicator of interest in Saskatchewan's mineral resources. This, in turn, may lead to exploration and possible industrial activity and expansion. From an ecological perspective, industrial activities can be classified as either intensive or extensive. An example of intensive activities is mining, in which very little land surface is actually disturbed during the process, and an example of extensive activities is natural gas development, in which many well sites can be distributed across a much larger area than is occupied by a single mine site. In both types of industrial activity, developments such as the creation of new roads and trails are of concern, particularly for their cumulative implications for biodiversity, habitat fragmentation and the spread of non-native species.

Figure 3.3 Mineral Disposition Activity in Saskatchewan (December 2005)



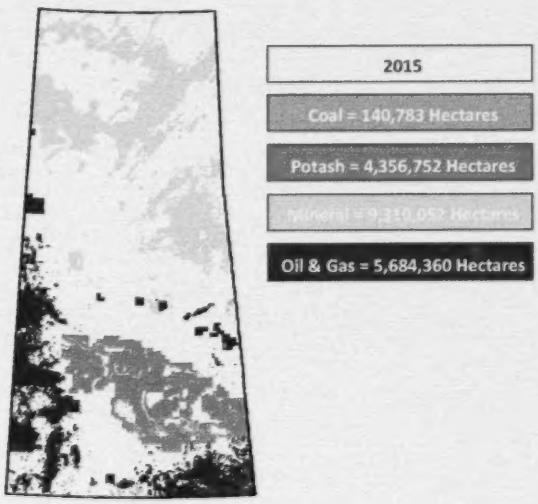
Source: Saskatchewan Ministry of Economy, 2012

Figure 3.4 Mineral Disposition Activity in Saskatchewan (December 2011)



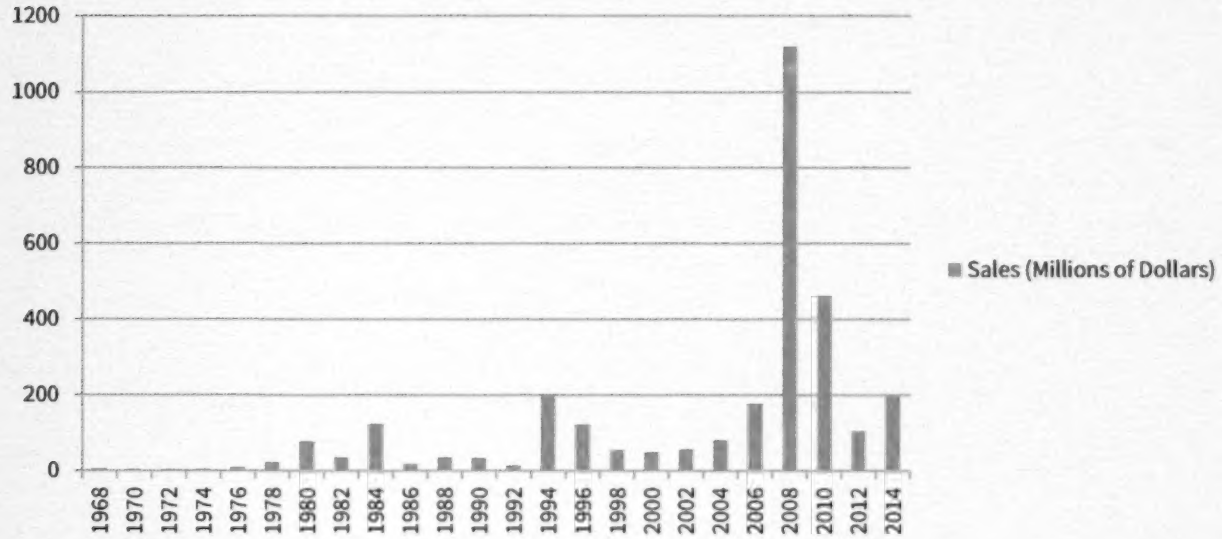
Source: Saskatchewan Ministry of Economy, 2012

Figure 3.5 Mineral Disposition Activity in Saskatchewan (March 2015)



Source: Saskatchewan Ministry of Economy, 2015

Figure 3.6 Value of Crown Land Mineral Sales in Saskatchewan for rights to explore and access Crown Minerals



Source: Saskatchewan Ministry of Economy, 2015

What actions are being taken?

All industrial activities are governed by both federal and provincial acts and regulations. These acts and regulations determine the province's expectation for the approvals process, licensing and permitting and operations. Major plans go through a thorough public review process before approvals are issued.

Environmental stewardship and sustainability are important to industry. The various non-renewable resource industry sectors in Saskatchewan employ environmental practitioners at their operations throughout the province, and invest in researching, predicting, monitoring, preventing and mitigating their effects on the environment. Environmental stewardship is a part of industrial planning from conception to production through to reclamation and decommissioning.

The Environmental Management and Protection Act (EMPA), 2010 and the Saskatchewan Environmental Code coming into force June 1, 2015 is a shift towards a results-based regulatory framework and a change in emphasis from rules and permits to a system focused on environmental results and outcomes.

As part of these legislative changes, the ministry will require Decommissioning and Reclamation (D&R) plans and financial assurances from all regulated Industrial Waste Works (IWW) facilities which include a variety of industries ranging from chemical plants to wood treatment facilities. This will be in addition to all mining operations which are already required to have D&R plans and Financial Assurances in place. Financial Assurances are financial guarantees provided by a proponent and are based on estimated costs to rehabilitate or restore the environment as a result of industrial activity.

Based on an average life of the facility for example, mine, pulp or paper, chemical plants, coal-fired power facilities, ethanol facilities and forestry facilities, financial assurances provide a guarantee of sufficient funding to manage environmental risks in the event that a proponent may face legal or financial difficulties. The ministry continues to work with individual proponents and industry stakeholders to develop appropriate financial assurance instruments.

3.3 Response Indicator: Area Under Zero-Tillage

Why is this indicator important?

Adoption of conservation farming practices like zero-tillage is producing significant improvements to Saskatchewan's air and water quality, biodiversity conservation and soil carbon storage (Hofmann 2008, Wicklum and Gray, 2010). Conventional tillage, conservation tillage and zero-till (or no-till) are defined by the amount of crop residue left on the ground (Hofmann, 2008). Crop residue is the vegetative material, often referred to as trash or litter, left after a crop has been harvested. It can include straw, stubble, leaves and stalks.

Conservation tillage is a method of soil cultivation that leaves the previous year's crop residue (e.g. wheat stubble) on fields to reduce soil erosion and runoff. Seeding that involves direct seeding into crop residue/soil is known as zero-till or no-till. The zero-till approach avoids any mechanical tillage of the soil and attempts to keep soil disturbance to an absolute minimum. In contrast to the multiple passes of equipment in the conventional approach, and the minimal tillage of conservation tillage, zero-till can involve just one pass through the fields for planting.

The greater the level of tillage, the greater the loss of soil organic matter. Organic matter is important for supporting soil biodiversity such as bacteria, fungi and earthworms that help cycle nutrients and increase the speed of pesticide breakdown. Organic matter also stores carbon, thus zero-till also provides substantial climate change benefits. By lowering the number of passes through the fields with conservation tillage or zero-till, farmers gain savings in fuel and labour. Nationally, total fuel expenditures and repair costs on farms using zero-till systems were approximately one third of those in typical conventional tillage (Hofmann, 2008). Reduced use of fuel not only lowers farmer costs, but also reduces air pollution and greenhouse gas emissions.

Minimizing tillage also supports climate change adaptation. Increased soil organic matter levels enhance moisture-holding capacity and reduce vulnerability to soil erosion. Improved soil health increases agriculture's resilience through severe droughts and extreme weather events and enables sustained productivity over the long term *(State of the Environment, 2013)*.

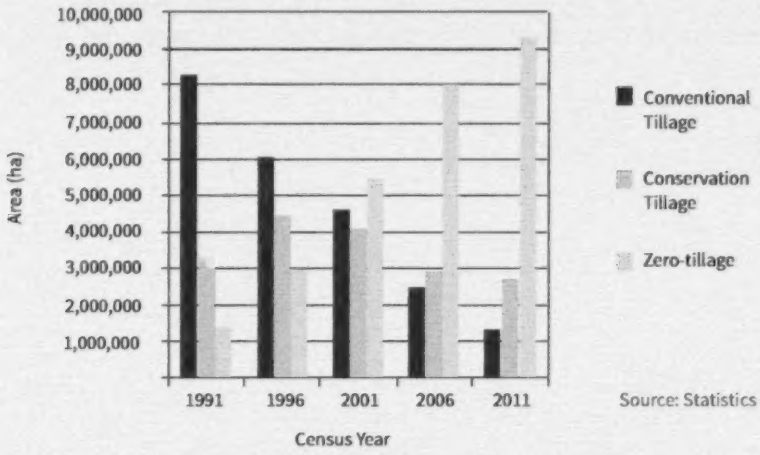
What does this indicator show?

Figure 3.6 shows the successful conversion to zero-till practice on farmland in Saskatchewan from 1991 to 2011 (Statistics Canada, 2011b). This information is taken from the 2011 Census of Agriculture and represents the most recent measure of the overall state of Saskatchewan agriculture and its wealth of data provides a valuable snapshot of the sector.

There has been a dramatic increase in the adoption of zero-till in Saskatchewan over the reporting period with a simultaneous decline in the use of conventional tillage. The level of conservation tillage has remained relatively unchanged. In 2011, 82 per cent of cropland in Saskatchewan was either conservation tilled or zero-tilled (Statistics Canada, 2011b).

An increase in soil cover over time indicates an improvement in environmental sustainability since the soil is more protected from degradation and is less likely to contribute to water contamination and atmospheric emissions (Eilers et al, 2010).

Figure 3.6. Area of Land Under Zero-tillage in Saskatchewan, 1991-2011



Source: Statistics Canada 2011

What actions are being taken?

The Saskatchewan Soil Conservation Association (SSCA) continues to advocate for the increased adoption of zero-tillage (SSCA, 2010). The SSCA and individual farmers' efforts, along with the rising costs in fuel, will likely mean that zero-till will continue to gain popularity across Saskatchewan to the benefit of agricultural ecosystems.

3.4 Response Indicator: Private Land Stewardship

Why is this indicator important?

Land management activities by private conservation organizations and individuals are a key component of sustainable land and water management. These conservation stewards play an important role, not only in maintaining and conserving natural areas through their activities, but also in providing social and economic benefits to the people of Saskatchewan as a whole *(2013 State of the Environment)*.

What does this indicator show?

Private land stewardship in this indicator is the status of Water Security Agency voluntary conservation agreements with private land owners for improved and acceptable management of land and farming operations near riparian areas, stream banks, etc.

Figures 3.8 and 3.10 show the number of voluntary private conservation stewards in Saskatchewan by watershed and the number of hectares covered under conservation agreements by watershed as of 2012 (Water Security Agency, 2012).

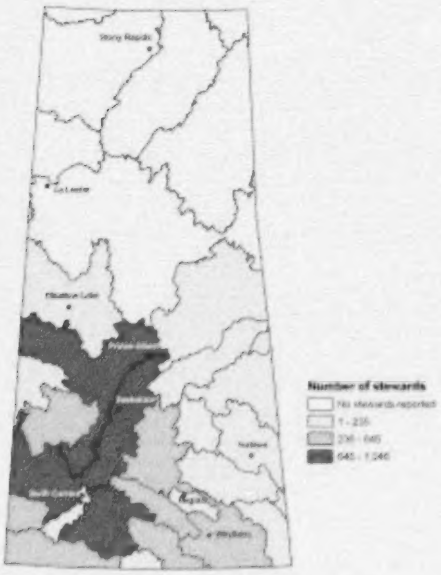
Refer to Figure 5.1 on page 68 for watershed names. The numbers of conservation stewards and the hectares covered under conservation agreements is the combined total of the stewards in the Prairie Stewardship Program, the Permanent Cover Programs I and II, and the Greencover Canada Programs. The Greencover Canada Programs also reflects the hectares conserved through conservation steward agreements with Ducks Unlimited Canada.

The number of voluntary conservation stewards is greatest in the North Saskatchewan River, Old Wives Lake, South Saskatchewan River, and Upper Qu'Appelle River Watersheds. This is an increase of one watershed (Upper Qu'Appelle River) compared to the number of conservation stewards by watershed recorded in 2008 (Figure 3.7). The number of hectares covered under conservation agreements is greatest in the Big Muddy Creek, Carrot River, Milk River, Moose Jaw River, North Saskatchewan River, Old Wives Lake, Quill Lakes, South Saskatchewan River,

Upper Qu'Appelle River, and Upper Souris River Watersheds. This is an increase of five watersheds (Milk River, Moose Jaw River, Quill Lakes, Upper Qu'Appelle River, Upper Souris River) compared to the number recorded in 2008 (Figure 3.9).

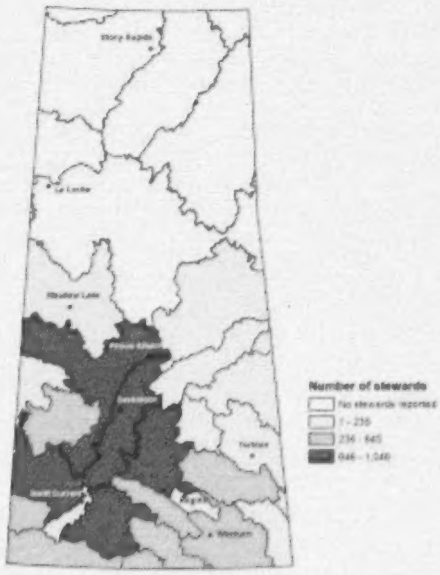
Further information on this indicator, detailing agreements and hectares covered by these voluntary land stewardship programs, can be found in the 2010 State of the Watershed Report (Saskatchewan Watershed Authority 2010).

Figure 3.7 Number of Conservation Stewards in Saskatchewan by Watershed: 2008



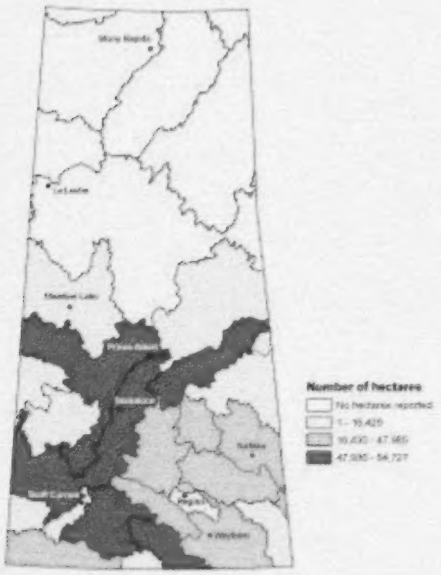
Source: Saskatchewan Watershed Authority

Figure 3.8 Number of Conservation Stewards in Saskatchewan by Watershed: 2012



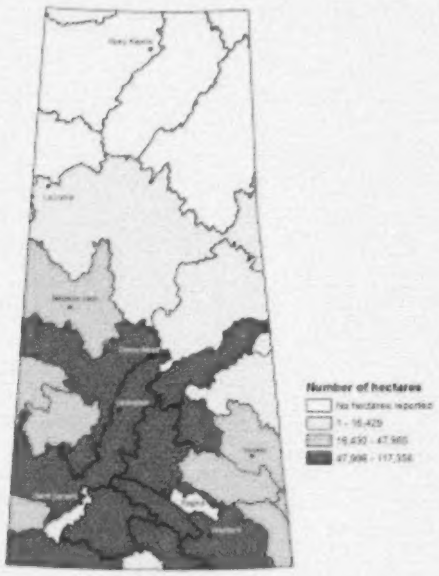
Source: Saskatchewan Water Security Agency

Figure 3.9 Area Covered Under Conservation Agreements in Saskatchewan by Watershed: 2008



Source: Saskatchewan Watershed Authority

Figure 3.10 Area Covered Under Conservation Agreements in Saskatchewan by Watershed: 2012



Source: Saskatchewan Water Security Agency

What actions are being taken?

Information included in the Private Land Stewardship Indicator is based on agreements between the Water Security Agency and owners of private land in the agricultural areas of Saskatchewan.

Additional private land conservation efforts, undertaken by environmental stewardship groups contribute to the environmental well-being of the province.

In 2014, the Ministry of Environment, in collaboration with the Ministry of Agriculture, announced a new land management initiative that will offer agricultural lessees the opportunity to buy eligible parcels of Crown land currently designated under *The Wildlife Habitat Protection Act (WHPA)*, while providing new legal tools to protect ecological values, regardless of ownership. *The Conservation Easements Act* was updated to provide continued protection of moderate ecological value of WHPA lands should they be sold with development of a Crown conservation easement. Additionally, a portion of the revenue from sales of WHPA lands will support programs and conservation projects through the Fish and Wildlife Development Fund and vacant lands will be assessed for possible future inclusion in WHPA.

The Representative Areas Network (RAN) and Land Use Planning

Representative areas act as reservoirs of biological diversity and as benchmarks for comparison with more heavily-utilized landscapes outside of the network.

Ministry-led conservation efforts, such as the Representative Areas Network (RAN), are also a key component to land stewardship in the province. The RAN is intended to conserve representative and unique landscapes throughout the 11 ecoregions of the province to maintain ecosystems that support native biological diversity.

RAN areas also serve to help maintain biodiversity and act as benchmarks when compared to managed landscapes. There are challenges in adding significant numbers of hectares to the RAN. In agricultural portions of the province, the vast majority of land is privately held and additions to the RAN are achieved in small quantities. In northern Saskatchewan, even though Crown land dominates, many interests must be considered and weighed to achieve a balance between conservation and economic development.

The greatest risk to achieving the RAN targets are increasing development pressures and the resulting developments that either decrease the ecological value of the land or take up lands fully so that they are not representative of a natural landscape. As well, lack of support for protected areas by some users is a risk. The measure of the number of hectares in the RAN is an indicator of the province's commitment to supporting the protection and retention of native habitat and of long-term ecological health and aligns with the key actions of maintaining a healthy and productive environment and minimizing impacts on the environment.

The ministry is working towards completion of the Provincial Representative Areas Network (RAN) which will result in protection of at least 12 per cent of the province. The RAN includes designated Crown lands that have been given a level of protection by legislation and private lands that are managed for biodiversity by agreement. These representative areas conserve biodiversity in a variety of recognized conservation lands such as parks, ecological reserves and pastures. They also act as benchmarks for measuring environmental change and ecological health.

The Ministry of Environment continues to identify, protect and manage sites within the Provincial Representative Areas Network. There are currently 6.2 million hectares (approximately 9.5 per cent of the province) in the RAN compared to 5.96 million hectares, or approximately nine per cent of the province as reported in the 2013 State of the Environment Report. The Pink Lake site was designated in 2013–14 and is the largest provincial designated protected area (366,000 hectares).

Land use planning processes, led by the Ministry of Environment, inform development and resource allocation decisions that are supported by First Nations and Métis communities, as well as diverse stakeholders and user groups. There are currently 10.4 million hectares of Crown land under approved land use plans with an additional 3.9 million hectares undergoing planning processes. As these land use plans are approved and recommendations for designation of proposed representative areas are implemented, more hectares will be added to the RAN.

There are currently 10.4 million hectares of Crown resource land under approved land use plans with an additional 3.9 million hectares undergoing planning processes. As these land use plans are approved and recommendations for designation of proposed representative areas are implemented, more hectares will be added.

3.5 Response Indicator: Waste Recycling

Why is this indicator important?

Diverting waste before it reaches landfills is an important way to reduce its impact on the environment. Much of what used to be called 'trash' or 'waste' is a valuable resource that can be re-used for environmental, social and economic benefits. Less waste means fewer landfills, diversion from existing landfills, less pressure on our natural resources, reduced risk from harmful materials, lower carbon emissions, as well job and wealth creation. Recycling is also an indicator of the public commitment to waste minimization and indicates shared responsibility for environmental stewardship.

The recycling indicators report on the actions of the ministry and its stewardship programs in preventing and reducing risks to human health, the environment, and to expanding solid waste management and recycling programs in the province.

What does the indicator show?

The ministry administers the enabling regulations for four industry-led stewardship programs and oversees a fifth program, the Beverage Container Collection and Recycling Program, through a contract with SARCAN, the Saskatchewan Association of Rehabilitation Centres' recycling division.

Figure 3.11 shows the proportions of various materials recycled in Saskatchewan from 2001 to 2014.

In general, recycling rates for beverage containters, waste electronics, used oil, scrap tires and waste paint in Saskatchewan are high and have remained so over the reporting period, with increasing rates in recovery for oil filters and oil containers. As of September 2013, SARCAN officially recycled its six billionth beverage container (SARCAN Recycling, 2014).

The ministry is proud to report that, from 2012 to 2014, 82 per cent of all deposit-paid, ready-to-serve beverage containers sold in Saskatchewan were recycled, which makes this the highest return rate of all beverage container programs in Canada.

Industry-led recycling programs report to the ministry on an annual basis; therefore, performance numbers are combined within the entire year's reporting period. At the end of 2013-14, used oil and waste paint programs reported increases in collection rates. Volume of recyclable material collected is expected to continue to increase.

More recent recycling efforts include electronic waste and paint. The Saskatchewan Paint Stewardship Program is managed by the paint industry through its non-profit association, Product Care. In 2013, the Saskatchewan Paint Stewardship Program collected 380,664 litres of waste paint. This includes 69,072 litres of paint collected and reused through the programs "Paint Exchange" initiative (Saskatchewan Paint Stewardship Program, 2013).

Saskatchewan is the first industry-led electronics recycling stewardship program in North America. Waste Electronic collection volumes from 2007 to 2013 are reflected in figure 3.12. The program began as Saskatchewan Waste Electronic Equipment Program (SWEEP) and on April 1, 2013 successfully transitioned into Electronic Products Recycling Association (EPRA).

In 2013, more than 3,000 metric tonnes of end-of-life electronics were collected. The program also surpassed the milestone of diverting 17,000 metric tonnes of end-of-life-electronics from landfills since the program's inception in 2007 (EPRA, 2014).

The expansion of waste electronic products collected from the industrial, commercial and institutional sectors, as well as the ministry's efforts to develop a Multi-Material Recycling Program (MMRP) and Agricultural Plastics Recycling Program, are expected to increase recycling volume in the future.

Key risks to maintaining or increasing recycling rates include market conditions (such as the value of recyclable materials and access to purchasers of recyclable materials), sufficient funding sources for recycling programs and sufficient public commitment (as illustrated through participation in recycling efforts and support for recycling fees and levies).

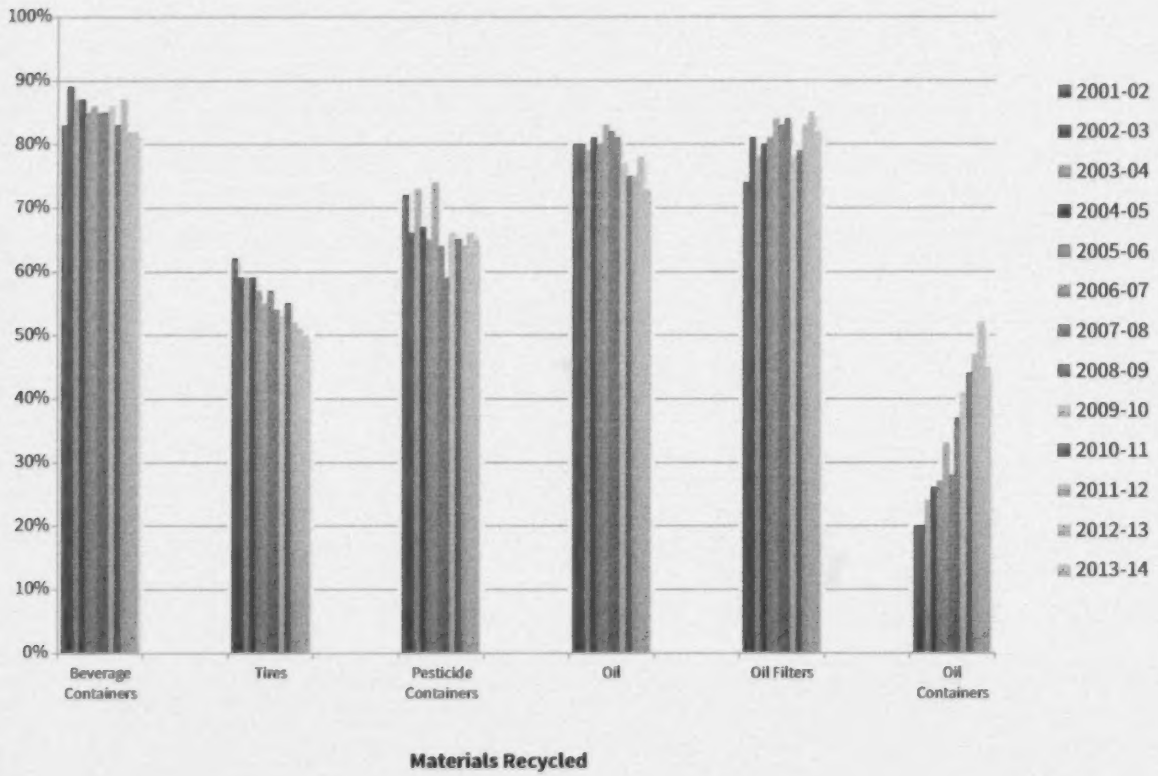
Over the last decade, the Saskatchewan Scrap Tire Corporation (SSTC) has been delivering a province-wide tire recycling program. In 2013, more than 799,416 tires were collected through the program for recycling. Since SSTC began operating in 1996, more than 20 million tires have been diverted from landfill disposal, more than 300 landfill tire stockpile sites have been cleaned up, recycling thousands of tires and reclaiming usable landfill space (SSTC, 2014).

CleanFARMS Inc.'s Pesticide Container Collection Program provides consumers, mainly agricultural producers, with an environmentally safe and convenient way to dispose of empty pesticide containers. Saskatchewan's agricultural producers generated approximately 2.2 million empty plastic pesticide containers in 2013. With proper cleaning, these containers can be recycled economically and in an environmentally safe fashion. CleanFARMS continues to work with the Saskatchewan Agricultural Stewardship Council (SASC), a multi-stakeholder group (growers, recyclers, municipalities, manufacturers, dealers, etc.) tasked with developing a province-wide program to collect and recycle grain bags (CleanFARMS, 2013).

The Saskatchewan Association for Resource Recovery Corporation (SARRC) is responsible for recycling used oil materials in Saskatchewan. Used oil recycling in 2013 was similar to 2012 with 18.74 million litres of used oil recycled for an annual recycling rate of 73 per cent. Oil filter recycling in 2013 stayed constant with 2012 levels at 2.07 million filters collected, 82 per cent of the overall 2.53 million oil filters sold and available.

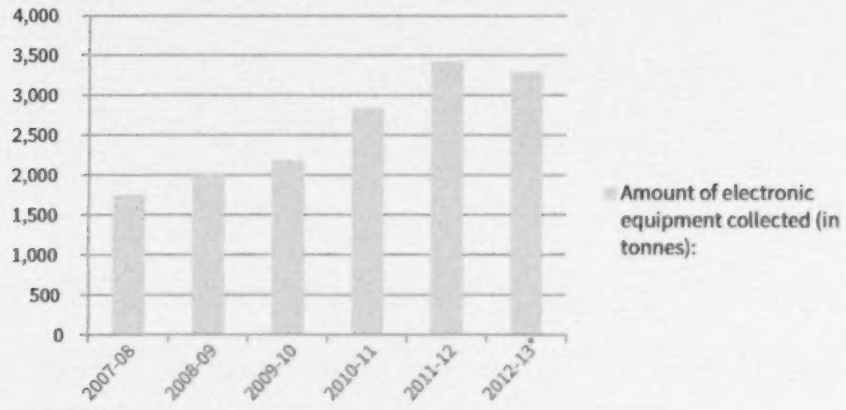
In 2014, antifreeze and diesel exhaust fluid containers were added to the oil container collection program. Since its inception in 1996, the used oil materials recycling program's total collection rates are: 268.47 million litres of used oil; 29.78 million oil filters; and 4.37 million kilograms of oil containers (SAARC, 2014).

Figure 3.11 Proportions of Materials Recycled in Saskatchewan, 2001-2014



Source: Saskatchewan Ministry of Environment, Environmental Protection Branch

Figure 3.12 Amount of Electronic Equipment Collected



Source: Saskatchewan Ministry of Environment, Environmental Protection Branch
*2012-13 Transition from SWEEP to EPRA

What actions are being taken?

As the economy continues to grow, reducing the amount of waste going to local landfills will help improve our environment and maintain our quality of life. In 2013, 19,120,254 litres of waste liquid and 44,817 tonnes of solid waste were diverted from landfills (Recycle Saskatchewan, 2014). Some of this material can be diverted into recycled products which will create new business and employment opportunities.

The Government of Saskatchewan is moving forward with implementation of a province-wide Multi-Material Recycling Program (MMRP). MMRP is a cost-sharing program between businesses and municipalities to help pay for the collection and recycling of household packaging and paper materials including printed paper, newsprint, cardboard, plastic, metal and glass packaging in the province.

Currently, municipal recycling programs are paid for by municipalities. Under MMRP, businesses and organizations that distribute packaged goods and paper to households in the province will now share responsibility for the cost of recycling these materials. Businesses that distribute or sell packaging and paper products in Saskatchewan are required under *The Household Packaging and Paper Stewardship Program Regulations* to participate in MMRP.

The MMRP will provide the framework to fund the collection and recycling of household materials. With the regulations now in place, it is expected that a non-profit association representing industry, will work with municipalities and other stakeholders to develop and implement the recycling program.

Conclusion

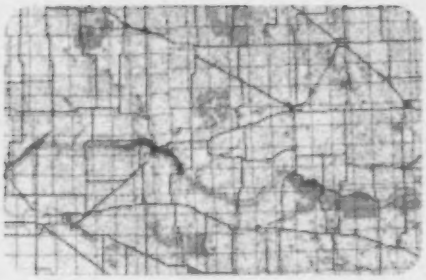
Various land uses and management practices determine the current status of land health and environmental sustainability in Saskatchewan. Changes in land use influence whether the trend is either towards or away from enhancing biological diversity. The key to maintaining the health of the environment is the sustainable use of our resources through greater integration between our economy and the ecosystems that support it.

The pressures on Saskatchewan's land are high and could increase with future industrial development as shown by the increase in mineral leases in the province. Continued industry leadership and innovation in environmental sustainability is required, in partnership with current regulatory reform in government, to help the province move towards a result-based approach to environmental management.

Working together is key in both private and public land stewardship, as shown by the efforts of individuals, organizations and government to secure and maintain healthy ecosystems that support native biological diversity. A private stewardship response indicator provides the status of programs that primarily focus on conservation stewards who own and manage private land in the agricultural areas of Saskatchewan. The Representative Areas Network (RAN) is a key indicator for land stewardship in the province.

Recycling waste is another example where the Government of Saskatchewan and local governments are working together with the private sector to establish recycling industries. Waste recycling in Saskatchewan is available for beverage containers, scrap tires, pesticide containers, used oil, oil filters and oil containers, electronic waste and paint. The province-wide multi-material recycling program will now provide the framework to fund the collection and recycling of household materials including printed paper, newsprint, cardboard, plastic, metal and glass packaging in the province.

Snapshot of Local Responses



Landscape Connectivity and Focused Habitat Securement Project

Habitat fragmentation of natural landscapes into small and isolated patches is one of the greatest threats to biodiversity. It affects the ability of all types of wildlife to find food, shelter and other necessities of life by preventing them from moving normally from place to place. Environmental Systems Assessment Canada, the Saskatchewan Wildlife Federation and the Nature Conservancy of Canada are collaborating on the project to improve landscape connectivity in Saskatchewan. The Go Green Fund provided $2.3 million to assist the proponents to map biodiversity movement corridors, secure and manage new conservation lands and corridors, and support habitat securement and stewardship for the benefit of the province's wildlife. Existing computer models were evaluated for their suitability to identify landscape connectivity in Saskatchewan. The most useful model was further customized for purpose, and ultimately provided ground-truthed maps that identified movement corridors on the ground. The Government of Saskatchewan will make the connectivity model available without charge to interested environmental organizations as an analytical tool to help inform their work on the landscape. More than 3,000 hectares (7,400 acres) of new conservation lands that augment and geographically connect existing protected sites have been secured. The selection and acquisition of conservation lands on the basis of landscape connectivity represents an entirely new approach to on-the-ground conservation in Saskatchewan.

Snapshot of Ministry Responses

Changes to Recycling Programs

The Used Petroleum and Antifreeze Products Collection Regulations came into effect January 1, 2014, replacing *The Used Oil Collection Regulations* which were introduced June 26, 1996. The amended regulations add antifreeze, antifreeze containers and diesel exhaust fluid containers to the list of products required to be included in a product management program.

The Saskatchewan Association for Resource Recovery Corporation (SARRC) is the non-profit industry organization that maintains the province-wide used oil, filter, antifreeze and oil/antifreeze/diesel exhaust fluid container recycling program. The 35 Eco-Centres, operated by SARRC across the province, provide drop-off points for the used petroleum products. The program is funded through environmental handling charges on the petroleum products. More information is available at usedoilrecyclingsk.com.

Audit Program Built on Partnerships and Collaboration

With the introduction of Saskatchewan's new Environmental Code and supporting legislation, the government initiated the compliance audit program within the Ministry of Environment to verify compliance to the new requirements. The ministry went through a pilot phase in 2014, during which the newly established Compliance Audit Unit collaborated with other branches within the ministry to identify potential auditees and to assemble and train a pool of auditors with the requisite expertise to audit any and all regulated industries and municipalities across the province.

For the pilot audit phase, potential auditees were identified using a combination of pilot audit criteria and risk-based criteria. What the ministry was looking for during this initial phase were proponents with a reputation for compliance with legislated requirements and a good working relationship with the ministry, but also with a variety of complex environmental aspects to challenge the audit tools and the auditors themselves. Moving forward, the pilot audit criteria will no longer be used and auditees will be identified primarily using risk-based factors.

In the case of facilities such as water treatment plants, which are jointly regulated by the ministry and the Water Security Agency (WSA), the ministry and the WSA formed a unique partnership in which they agreed to share resources and skills to verify compliance. Selected individuals from across the ministry and the WSA took part in specialized audit training in April 2014 and subsequently carried out pilot audits throughout the province led by experienced auditors. The pool auditor model provides many benefits including increasing audit capacity and leveraging technical knowledge and expertise in support of reaching the audit objectives, to achieve positive environmental outcomes.

Throughout 2014, the audit teams verified compliance to existing legislation such as *The Environmental Management and Protection Act, 2002* but now that the program's processes have been established and verified and the new Code and supporting legislation have received Royal proclamation, the audit teams are preparing to transition to the new requirements. Through the pilot phase, the core elements of the audit program have been tested and verified in the preparation for the transition to the new Code as the ministry implements the results-based regulatory framework.

Hazardous Materials Response

As part of the Environmental Protection Branch, the ministry's provincial hazardous materials co-ordinators (PHMCs) provide emergency management in response to any incident that threatens the environmental quality of the water, land or air in Saskatchewan. This includes responding to and supporting communities, responsible parties, and other agencies to resolve incidents to ensure public safety and protection of the environment, for instance, assisting various authorities in the proper handling and disposal of laboratory chemicals.

The Spills and Hazardous Materials (Hazmat) response program co-ordinators undergo more than 500 hours of specialized training in addition to annual ongoing training to assume the duties. Hazmat personnel are available 24 hours a day, seven days a week and co-ordinate activities with local authorities for incident command.

In October 2014, the co-ordinators responded and remained on scene when rail cars containing solvent and hydrochloric acid derailed and exploded near Wadena, Saskatchewan. The resulting fire and smoke required evacuation of the surrounding area, with the rural municipality declaring a state of emergency.

The ministry's PHMCs worked with the communities impacted by the derailment and railway representatives to monitor air quality and to establish and measure response performance. In these circumstances, the ministry ensures that human health and safety is not compromised and response actions are beneficial to the public and the environment.

After a Hazmat incident, the branch follows up with compliance monitoring to ensure reclamation activities have been completed and also provides advice on environmental management and remediation requirements. In 2014, the Ministry of Environment followed up on 721 incidents.

HABISask: (Fish and Wildlife Branch)

The Hunting, Angling and Biodiversity Information of Saskatchewan application, or HABISask, is a client-centred, online mapping application that will provide stakeholders, the public and government clients with one-stop hunting, angling and biodiversity information. Developed in conjunction with stakeholders and client groups such as the Saskatchewan Wildlife Federation, the Wildlife Advisory Committee (made up of multiple client group representatives) and the Saskatchewan Petroleum Industry Government Environmental Committee (SPIGEC), HABISask will also help ministry staff with environmental reviews and in identifying conservation opportunities and shortfalls so they can be addressed.

The HABISask app will also be used by:

- industry and consultants to access habitat information when planning for development projects prior to construction;
- hunters and anglers to plan recreational activities;
- First Nations and Métis, municipal, provincial and federal government agencies and non-government organizations to conduct land use planning and prioritization of conservation efforts;
- naturalists and interested public to plan recreational activities with access to the best available information; and
- research partners to plan research related activities with access to the best available information. HABISaskcan be found at: www.environment.gov.sk.ca/maps.

Unmanned aerial vehicles (UAVs) for environmental protection, monitoring and research

The Spatial Information Management and Modeling Unit within the Technical Resources Branch of the Ministry of Environment has been actively investigating and promoting the use of unmanned vehicles to provide timely and cost-effective methods of acquiring environmental data in relation to environmental protection, monitoring and research since late 2012.

The UAVs can be used for various applications in ministry work, including: mapping rare and endangered features of the environment; aerial photography of crime scenes such as illegal dumping and wildlife infractions; volumetric analysis of sand and gravel leases; remotely investigating collapses at historical coal mine workings; wildlife management and habitat related surveys; monitoring the spread of invasive species; remote observation for wildfire management and prescribed burns, as well as related regulatory implications. In addition, Technical Resources has undertaken field studies conducted in partnership with the University of Regina's Department of Geography and Environmental Studies to identify and map sensitive slopes using a combination of high-resolution orthophotography (geometrically corrected aerial photograph to produce uniform scale) and LIDAR (laser-illuminated detection and ranging sensor). In time, investigations will expand to include ground and water-based solutions where they may help reduce overall costs of collecting data and/or reduce worker exposure to unsafe conditions.

Highlights for Land

Various land uses and management practices determine the current status of land health and environmental sustainability in Saskatchewan. Changes in land use influence whether the trend is either towards or away from enhancing biological diversity. The key to maintaining the health of the environment is the sustainable use of our resources through greater integration between our economy and the ecosystems that support it.

The pressures on Saskatchewan's land are high and could increase with future industrial development as shown by the increase in mineral leases in the province. Continued industry leadership and innovation in environmental sustainability is required, in partnership with current regulatory reform in government, to help the province move towards a result-based approach to environmental management.

Working together is key in both private and public land stewardship, as shown by the efforts of individuals, organizations and government to secure and maintain healthy ecosystems that support native biological diversity. A private stewardship response indicator provides the status of programs that primarily focus on conservation stewards who own and manage private land in the agricultural areas of Saskatchewan. The Representative Areas Network (RAN) is a key indicator for land stewardship in the province.

Recycling waste is another example where the Government of Saskatchewan and local governments are working together with the private sector to establish recycling industries. Waste recycling in Saskatchewan is available for beverage containers, scrap tires, pesticide containers, used oil, oil filters and oil containers, electronic waste and paint. The province-wide multi-material recycling program will now provide the framework to fund the collection and recycling of household materials including printed paper, newsprint, cardboard, plastic, metal and glass packaging in the province.

The status and trend of the five land indicators reported on in this chapter are summarized as follows:

3.1 **Agricultural Land Cover** – Positive agri-environmental conditions exist with a continual decreasing trend in the area of summerfallow and increasing trend in tame or seeded pasture land cover.

3.2 **Mineral Disposition Activity** – The trend in mineral disposition activity since 2005 has increased as reflected by the dale of sub-surface mineral leases. This trend has leveled off in recent years as reflected by the decreasing value of Crown land sales for mineral exploration and development.

3.3 **Area Under Zero-till** – As of 2011, positive agri-environmental conditions exist with a continual increasing trend in zero-till practices and no significant change in conservation tillage in 2011. 82 per cent of cropland in Saskatchewan was either conservation tilled or zero-tilled.

3.4 **Private Land Stewardship** – As of 2013, the indicator shows a positive environmental response with increasing trend in both the number of voluntary conservation stewards and the number of hectares covered under conservation agreements as defined by watershed.

3.5 **Waste Recycling** – recycling rates are high with increasing rates in recovery for oil filters and oil containers. The expansion of waste electronic products collected from industrial, commercial and institutional sectors as well as the ministry's efforts to develop a Multi Material Recycling Program (MMRP) will increase recycling volumes in the future.

forest

Key Points

- Saskatchewan's forests are diverse, and half of the forested land in the commercial forest zone is considered mature to very old.
- Natural disturbances, such as wildfire and insect infestations, play a major role in changing the forest landscape.
- It is uncertain how climate change will affect natural disturbance regimes.
- In the last few years harvesting of the annual allowable cut has increased.
- Approximately 89 per cent of harvested forest areas have been successfully regenerated.

Forests are an important part of Saskatchewan's economy and environment. More than half of the province is forested, providing many benefits. As stewards of the forest resource, the Government of Saskatchewan is committed to its sustainable management. This means that the government will balance the human use of the forests for various socio-economic and cultural purposes with the need to protect the long-term health of forest ecosystems (Saskatchewan Ministry of Environment, 2009).

Saskatchewan forests are also home to many thousands of species of plants and animals within a variety of ecosystems. Boreal forests have ecosystems that are influenced over time by natural disturbances such as insects and disease outbreaks and wildfires. Maintaining the natural range of ecosystems results in a more resilient forest better equipped to recover from human and natural disturbances.

Indicators for Forest

Condition

4.1 Forest Type and Age Class – describes the forest diversity of the managed portion of the public forest known as the commercial forest zone, and is intended to track changes in forest ecosystem diversity over time.

Stressor

4.2 Proportion of Provincial Annual Allowable Cut Utilized – tracks the volume of forest harvested each year compared to a defined sustainable annual allowable cut; a measure of sustainable economic opportunity being realized over time. Forest harvesting is a human disturbance that affects the forest landscape. However, the area of forest harvested each year is much less than that disturbed by wildfires. Forest managers are working to make human disturbances associated with logging more closely resemble natural disturbances.

4.3 Forest Wildfire Disturbance – as one of the dominant natural agents of change in the boreal forest, shaping and reshaping the forest landscape, this indicator tracks wildfire over time.

4.4 Forest Insect and Disease Disturbance – as another major natural agent of change, this indicator tracks the levels of insect and disease infestations in the boreal forest. Insects such as the eastern spruce budworm (Choristoneura fumiferana) are a significant disturbance agent and a natural part of the ecosystem periodically affecting large areas of the forest. Mountain pine beetle is an impending threat to Saskatchewan's jack pine forests.

Response

4.5 Effective Renewal – Relates to long-term forest productivity as the proportion of timber harvested area successfully regenerated. In other words, tree cover is restored in harvested areas to an accepted and measurable standard. Forests that are regenerated successfully are essential to a long-term sustainable flow of wood products and the maintenance of ecosystem diversity and productivity.

4.1 Condition Indicator: Forest Type and Age Class

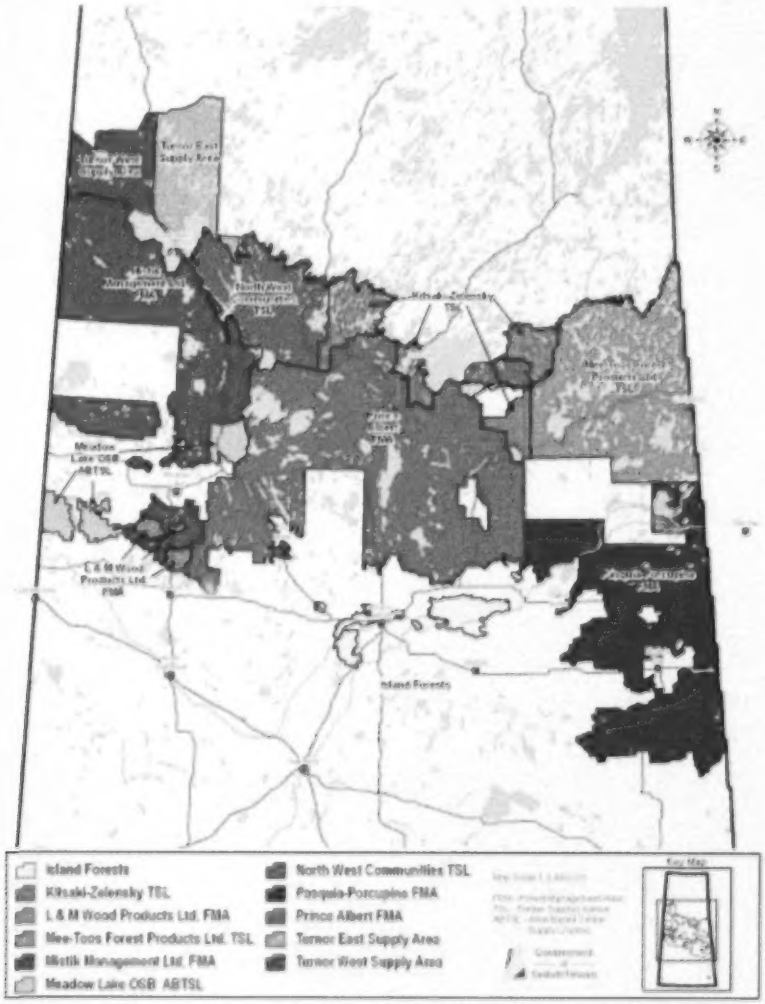
Why is this indicator important?

In order to maintain the forest values important to Saskatchewan residents (such as wildlife, pristine mature forests, forest products, forestry jobs, etc.), the natural forest condition and changes to it must be understood and sustainable forest management practices employed.

The provincial forest covers the northern half of Saskatchewan, an area of approximately 34.3 million hectares or 53 per cent of Saskatchewan. The area of the provincial forest that is viable for timber harvesting and receives the most impacts from human activities is called the commercial forest zone, approximately 11.6 million hectares, that is the area south of the Churchill River and north of the agricultural forest fringe (see Figure 4.0). The commercial forest zone has a diversity of forest types and ages. Maintaining the natural range of ecosystems results in a more resilient system, helping to sustain overall biological diversity.

Figure 4.0 Commercial Forest Zones in Saskatchewan, 2012

Source: Saskatchewan Ministry of Environment 2013



What does this indicator show?

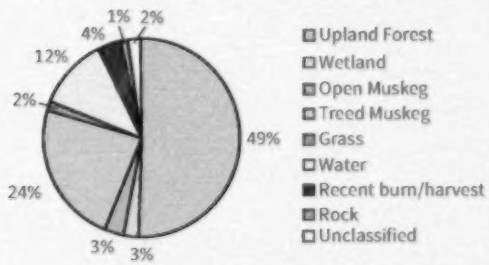
Between 1996 and 2006 forest inventories were completed by forest companies having forest management agreements for approximately 60 per cent of the commercial forest zone. Forest inventories of the remaining 40 per cent of the commercial forest zone were prepared by government during the 1980s, with the exception of the Island Forests which were prepared in the 2000s.

Figures 4.1, 4.2 and 4.3 illustrate the distribution of forest types and forest age classes based on the most recent inventory data.

Figure 4.1 shows that about half of the commercial forest zone is upland forest (forest that is valued for harvesting), while the rest is made up of other ecosystems such as muskegs, wetlands, open water, as well as recent disturbances such as wildfire and harvest. Figure 4.2 shows the diversity of ecosystems that exists within the forested portion of the commercial forest. This diversity is largely the result of differing soils, moisture regimes and previous disturbance history, mostly natural but sometimes human-caused. The three most abundant forest types are: black spruce-tamarack, trembling aspen-birch and black spruce-jack pine forest types. Figure 4.3 shows the combined hardwood-softwood age of all the forest ecosystems. More than half of the commercial forest is currently either mature (70 to 90 years), old (91 to 120 years), or very old (120-plus years). Wildfire fighting efforts as described in Indicator 4.3 can be attributed to successful protection of the mature and old forest types at these levels.

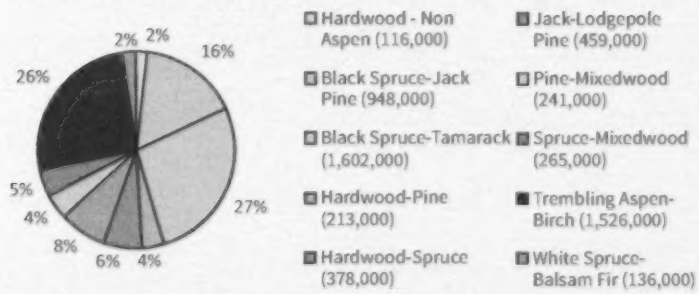
Approximately 258,455 hectares of forest is disturbed over a five-year period by various forest replacing disturbance events (Table 4.1). This equates to two per cent of the gross area (four per cent of the forested land area) of the commercial forest zone changing from an immature, mature or old age class to a young age class over a five-year period.

Figure 4.1 Forest Distribution in the Commercial Forest Zone in Saskatchewan



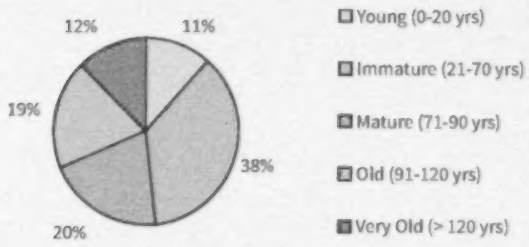
Source: Saskatchewan Ministry of Environment, Forest Service Branch

Figure 4.2 Forest Types (ha) in the Commercial Forest Zone in Saskatchewan



Source: Saskatchewan Ministry of Environment, Forest Service Branch

Figure 4.3 Seral Stages of Forest in the Commercial Forest Zone in Saskatchewan as of April 2009



Source: Saskatchewan Ministry of Environment, Forest Service Branch

Table 4.1: Forest Replacing Disturbance Events in the Commercial Forest Zone in Hectares

Forest Changing Disturbance Type	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	Five-Year Disturbance Total (Ha)
Blowdown	60	600	51,000	21,749	4,976	78,385
Wildfire	14,313	30,010	705	51,675	3,764	100,457
Area Harvested	10,235	13,469	12,705	20,986	22,200	79,595
Total						**258,437**

What actions are being taken?

The Saskatchewan Forest Vegetation Inventory (SFVI) standard was developed to identify the type, extent and conditions of vegetation, where it exists and what changes are occurring. Government, Forest Management Agreement (FMA) holders, and other clients and partners use the SFVI Forest Inventories to assist in the decision-making and reporting for various purposes such as: forest management, wood supply analysis, carbon modeling, biodiversity monitoring, wildfire management and wildlife habitat classification.

A National Forest Inventory (NFI) was designed in 1997 to provide information to assess the sustainable management of Canada's forests. The NFI is a collaborative effort of federal, provincial and territorial governments from across Canada. The NFI consists of a network of 20,000 sampling points across Canada. The ongoing 10-year re-measurement cycle provides a continuous record of forest change and consistent information on the state of sustainable development of Saskatchewan's forests and all forests within Canada.

Saskatchewan is managing the provincial forest to a variety of age classes in order to keep the forest healthy and more resilient, as older forests are more prone to insect and disease infestations. Approval of the forest industry annual operating plan by the government considers whether the proposed operations on the ground align with commitments to retain seral stages in the forest made in forest management plans. Forest management plans contain the strategies for managing age class and other landscape forest values.

The Forest Service Branch is working with other provinces and agencies to determine what the historical distribution of age classes and forest types were. Historical distribution is mainly determined by natural change events like fire. This information will be used to set targets for maintaining the composition of forest types within the natural range of variation.

4.2 Stressor Indicator: Proportion of Provincial Annual Allowable Cut Utilized

Why is this indicator important?

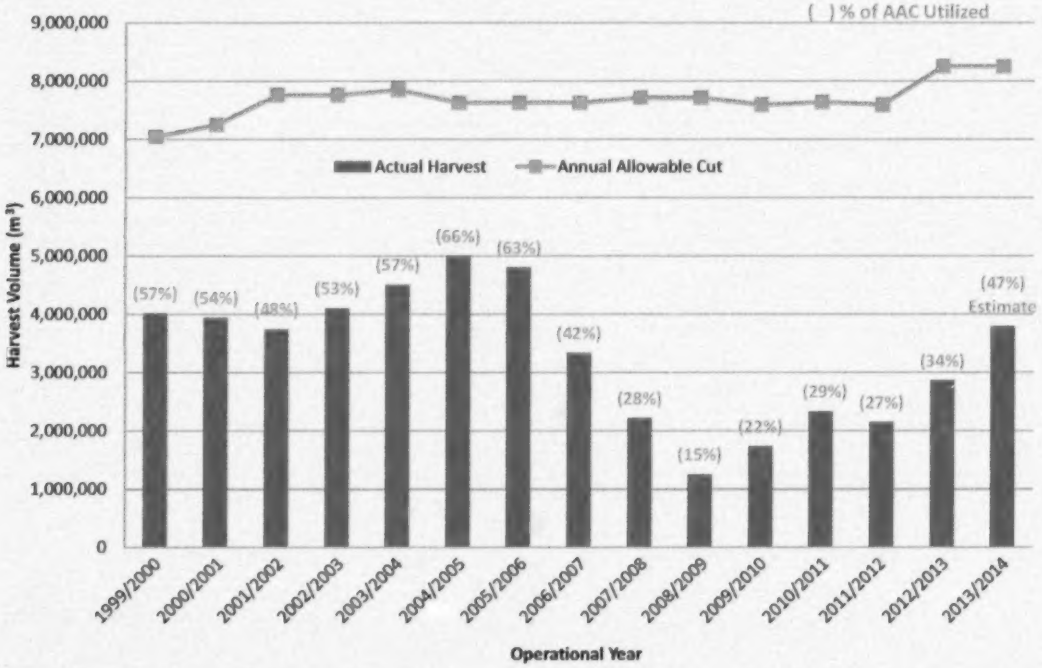
Annual sustainable timber harvest is called Harvest Volume Schedule (HVS) in Saskatchewan, or Annual Allowable Cut (AAC) in other jurisdictions. The HVS is determined for a licence area, based on assessments of economic, social and environmental values as processed through forest estate models over a 200-year timeframe. Keeping the annual harvest level under or equal to the HVS is one of the principles for sustainable forest management.

What does this indicator show?

Figure 4.4 shows the total annual calculated HVS relative to the actual total annual volume of timber harvested from 1999–2000 to 2013–2014 in Saskatchewan's commercial forests. The 10-year average harvested area within the commercial forest zone is 17,731 hectares per year.

Over the last 10 years, the HVS for Saskatchewan's forests has been relatively constant, between seven and eight million cubic metres of timber per year. Each licensed forest area (forest management agreement areas and area-based term supply licence areas) have an HVS calculated for them. While the forest could sustain this harvest level, in the northern portion of the commercial forest zone the lower quality of wood, higher harvest and transportation costs, and limited infrastructure will affect how much of the available volume can be realized. The actual amount of timber harvested each year has been far less than the HVS and has even declined in recent years, largely as a result of depressed forest products, markets and the global recession. Currently, actual harvest levels are on the rise as the Saskatchewan forest sector rebounds, in 2013-14, the total harvest volume in cubic metres was estimated at 3.67 million (1.35 million cubic metres of softwood and 2.32 million cubic metres of hardwood).

Figure 4.4 Saskatchewan Timber Harvest History



Source: Ministry of Environment, Forest Service

What actions are being taken?

The Ministry of Environment supports the efforts by the Ministry of Economy, Forestry Development Branch to grow and develop the Saskatchewan forest sector with the long-term goal of full utilization of the HVS.

A new standard is under development under the Saskatchewan Environmental Code for 20-year forest management plans, which will ensure sustainable harvest levels are consistent with long-term management objectives for a variety of environmental, economic and social forest values.

Wood supply analyses were completed and harvest volume schedule reports were prepared in 2011 for the following timber supply zones: North West; Kitsaki-Zelensky; and Mee-Toos.

Additional volume in the Prince Albert FMA will be allocated to independent timber operators through a formal request for proposals process. The Forest Service Branch is finalizing the allocation of timber to independent operators through the issuance of term supply licences and permits.

The 10-year renewal cycle for forest management plans that are developed by FMA licensees are coming due for several licences: Prince Albert FMA in 2015; Pasquia Porcupine in 2015; and Mistik Management in 2017. The government has led a forest management plan process for the Island Forests which is scheduled to be completed in 2016.

4.3 Stressor Indicator: Forest Wildfire Disturbance

Why is this indicator important?

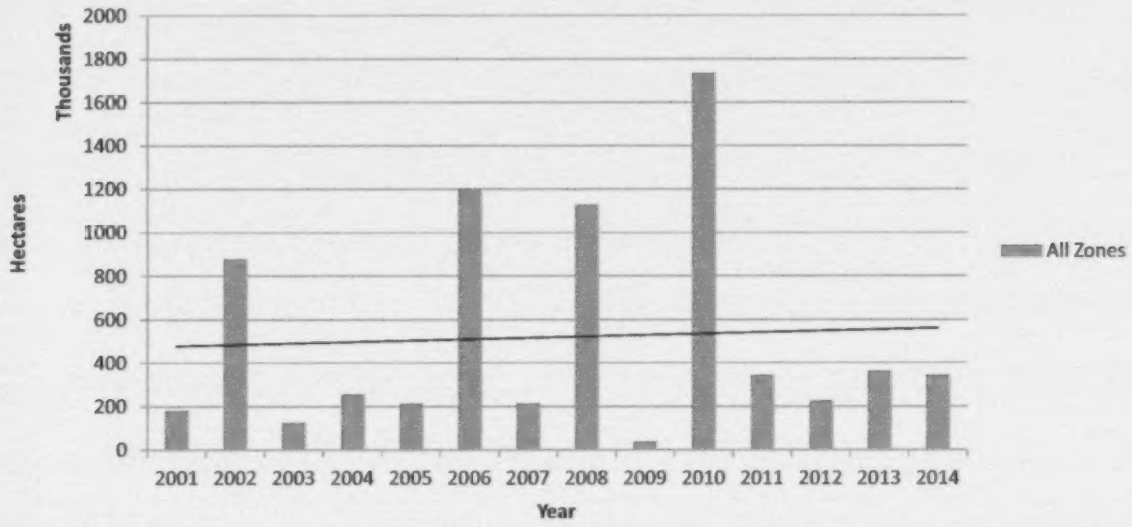
Wildfires are the single largest source of natural disturbance in the boreal forest in Saskatchewan. Over time, they create the mosaic of ecosystems and their associated biodiversity that characterize the boreal forest and provide the template for sustainable forest management. Some experts have predicted that wildfire activity is increasing due to global climate change (PARC, 2010) resulting in longer wildfire seasons with drier, more intense burning conditions and larger areas of burn. There is uncertainty regarding whether or not increased wildfire activity, which results in increased smoke on the landscape, has an effect on global warming. New research suggests that although not on the same level as fossil fuel emissions, smoke could be worsening climate change more than previously thought[1]. Area burned indicators may be useful to detect these potential changes in the future.

What does this indicator show?

The total area burned by wildfires each year in Saskatchewan is extremely variable (Figure 4.5). In some years, burn areas are minimal, and in other years, over one million hectares have been affected. This variability is attributed to annual variation in weather patterns, particularly with respect to precipitation and temperature. The 10-year average area burned for the entire provincial forest is 510,352 hectares. Figure 4.6 shows the annual commercial forest zone burned in Saskatchewan from 2001 to 2014. The 10-year average area burned in the commercial forest zone is 70,709 hectares. The trend for this indicator shows a slight increase in area burned overall, with a decrease in area burned in the commercial/community zones. Wildfire management strategies based on complete suppression action applied to full response zones (including commercial timber and community zones) have the greatest impact on the area burned. Within the observation and modified response zones, where wildfires burn more naturally, climate change impacts are better represented.

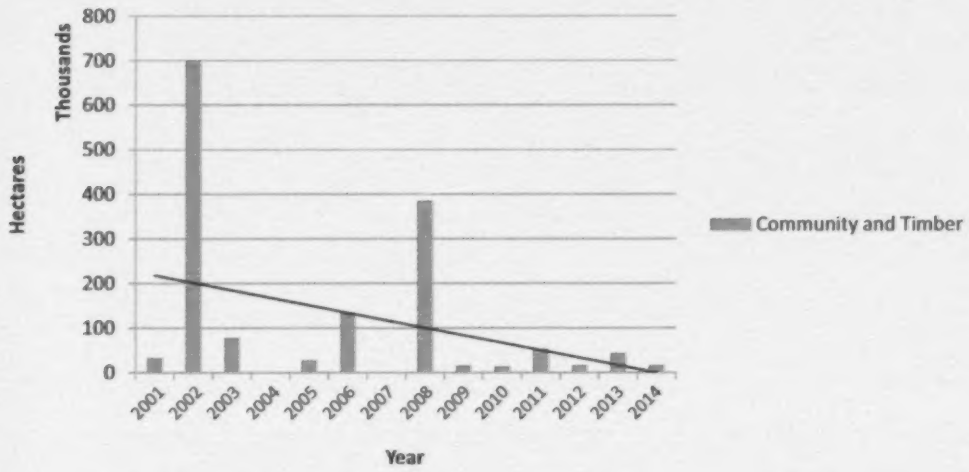
[1]Scientific America article Wildfire Smoke Proves Worse for Global Warming By Elizabeth Harball and ClimateWire (with permission from Environment & Energy Publishing, LLC. www.eenews.net).

Figure 4.5 Annual Total Area Burned by Wildfires in Saskatchewan, 2001-2014



Source: Saskatchewan Ministry of Environment, Wildfire Management Branch, 2014

Figure 4.6 Total Hectares Burned in the Commercial Forest Zone in Saskatchewan, 2001-2014



Source: Saskatchewan Ministry of Environment, Wildfire Management Branch, 2014

Table 4.2 Number of Wildfires and Area Burned Statistics

NUMBER OF WILDFIRES/YEAR		AREA BURNED (HA)			Percentage of Total Area Burned	
Year	Number of Wildfires	Community and Timber	Modified Response and Observation Zones (Mod/Obs)	All Zones	% Full Response Zone (FRZ)	% Mod/Obs
2014	397	15,679.60	327,721.20	343,400.80	5%	95%
2013	429	43,663.30	319,358.40	363,837.10	14%	88%
2012	409	16,116.70	211,394.70	227,511.40	7%	93%
2011	303	53,152.07	290,567.00	343,719.07	15%	85%
2010	571	13,657.92	1,721,140.00	1,734,797.92	1%	99%
2009	511	15,769.73	21,789.44	37,559.17	42%	58%
2008	599	385,432.07	744,747.99	1,130,180.06	34%	66%
2007	370	1,203.75	211,709.47	212,913.22	1%	99%
2006	501	134,087.20	1,069,641.30	1,203,728.50	11%	89%
2005	323	28,327.00	185,446.45	213,773.45	13%	87%
2004	329	847.4	257,284.33	258,131.73	<1%	>99%
2003	642	77,821.40	48,768.30	126,589.70	61%	39%
2002	880	698,501.78	181,108.50	879,610.28	79%	21%
2001	857	32,098.50	151,331.90	183,430.40	17%	83%
10 Year Average (2014)	**441**	**70,709**	**510,352**	**581,142**	**14%**	**86%**

What actions are being taken?

The Wildfire Management Branch of the Ministry of Environment has adopted a number of wildfire management strategies (Saskatchewan Ministry of Environment, 2013a) in conjunction with Wildfire Management Strategy Zones (Figure 4.7) (Saskatchewan Ministry of Environment, 2013b). The objectives of the management strategies are to ensure values at risk are protected, while allowing wildfire to assume its natural and beneficial role on the boreal landscape. This approach reduces the extreme costs sometimes associated with attempting to suppress all wildfires, a strategy that is, at best, unattainable and at worst, allows for an increased probability of the occurrence of a catastrophic wildfire event due to fuel loading.

The wildfire management strategies direct the way the province responds to wildfires and many factors are considered when deciding what actions to take on any particular forest fire. The Ministry of Environment believes that healthy, vibrant forests that are naturally renewed by fire, or through forest harvesting practices that approximate the disturbance created by wildfire, are in the best interest of Saskatchewan residents and businesses. However, aggressive protection action to suppress wildfires that threaten values at risk is the only appropriate action, such as those wildfires that occur near communities, businesses or provincial infrastructure or within the province's commercial forest zone. New forest fires are mapped every year (Figure 4.8), creating a database of landscape disturbances caused by wildfire in northern Saskatchewan for more than 60 years (Saskatchewan Ministry of Environment, 2013c). This is an important planning tool for understanding the impact of wildfire on timber volume allocations and wildlife management.

Other elements of the wildfire strategy include: daily public reporting of the current status of wildfires provincially during the wildfire season; fire bans during periods of high wildfire risk; the operation and maintenance of weather and fire observation towers; wildfire education and prevention programs; and suppression expertise that includes trained professionals undertaking ground and aviation support operations.

Projects to improve program delivery include the implementation of a camera-based tower detection and monitoring system, enhancement of a wildfire integrated information system (WIIN) that includes automated dispatch and resource tracking functions and an online-based burn permitting system. Current capital infrastructure projects include the Aerial Fleet Upgrade program and the Southend Fire Base re-development.

Figure 4.7 Wildfire Management Strategy Zones

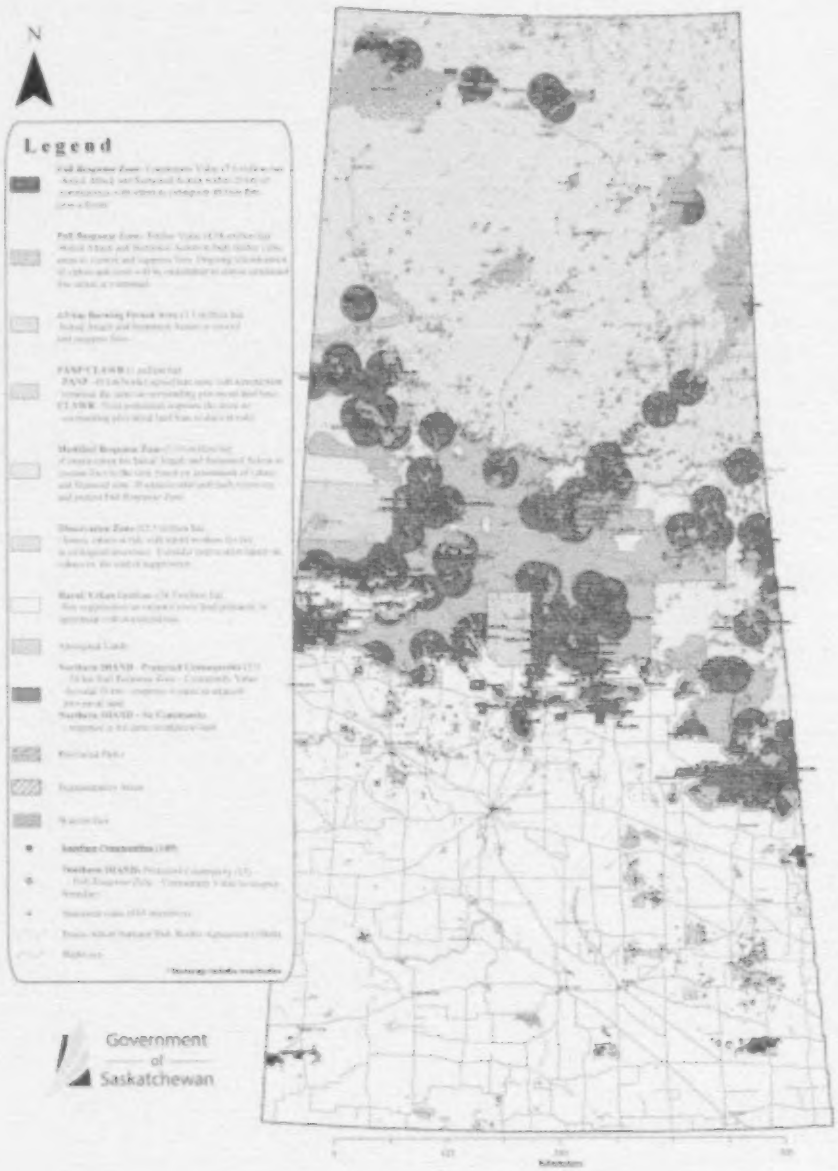


Figure 4.8 Wildfire History, 1945-2014

4.4 Stressor Indicator: Forest Insect and Disease Disturbance

Why is this indicator important?

Disturbance to Saskatchewan's forests by various insects and diseases also plays a significant role in forest composition and structure, and has a significant impact on sustainable forest management when there are outbreaks. There are a number of native species that serve as agents of change in the forest, such as forest tent caterpillar (Malacosoma disstria), large aspen tortrix (Choristoneura conflictana), eastern larch beetle (Dendroctonus simplex) and eastern spruce budworm (Choristonerua fumiferana). Eastern spruce budworm is a major insect pest that disturbs and damages spruce forests in Saskatchewan. Repeated moderate and severe defoliation by this caterpillar kills trees.

However, climate change and changes in annual weather patterns may be affecting the numbers and distribution of native and invasive forest pests. Range expansion and changes in biology and the timing of life cycles may cause their effects to be greatly magnified over time (Logan and Powell 2004).

In addition to spruce budworm, the most significant and potentially devastating forest insect threat is mountain pine beetle (Dendroctonus ponderosae), which is presently only found in Saskatchewan in the Cypress Hills area in association with lodgepole pine. In British Columbia this insect has killed millions of hectares of lodgepole pine forest and is moving eastwards, having reached Grande Prairie and east of Slave Lake in central Alberta where there are lodgepole pine and jack pine hybrid trees. In 2010 it was confirmed that jack pine is a suitable host[1], significantly elevating the risk that mountain pine beetle could kill jack pine forests throughout Saskatchewan and right across to eastern Canada if it continues to spread eastward unchecked and becomes established in Saskatchewan's northern jack pine forests.

Mountain pine beetles attack pine trees by laying eggs under the bark. When the eggs hatch, the larvae excavate the phloem area beneath the bark and eventually cut off the tree's supply of water and nutrients. The beetles also carry a blue stain fungus that serves to overcome the tree's natural defenses by blocking the xylem and phloem resulting in desiccation and disruption of the tree's ability to produce defensive resins[2].

What does this indicator show?

Figure 4.9 shows the annual area of forest infested by spruce budworm in Saskatchewan from 1990 to 2014. It also shows the annual area treated with the natural insecticide Btk (Bacillus thuringiensis kurstaki) in efforts to manage the outbreak of the insect and to preserve high-value merchantable forest stands.

The eastern spruce budworm is a periodic forest disturbance agent; outbreaks in eastern Canada typically occur on 30- to 35-year cycles. A substantial outbreak of spruce budworm occurred in Saskatchewan between 1996 and 2005. The Ministry of Environment began spraying affected areas with Btk as early as 1992 in hopes of minimizing the area affected. However, the area sprayed is relatively small in comparison to the total area under attack. The infestation reached its peak in 2002 and returned to pre-outbreak levels in 2008. The spruce budworm outbreak in effect has collapsed throughout the prairie region. The 10-year average of moderate and severe defoliated area within the commercial forest zone is 66,415 ha.

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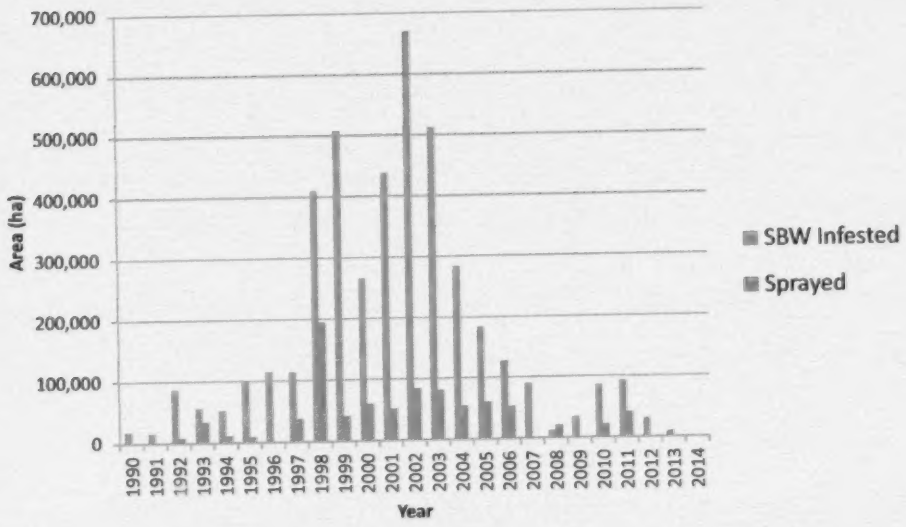
[1] C. CULLINGHAM, J. COOKE, S. DANG, C. DAVIS, B. COOKE and D. COLTMAN. 2011. Mountain pine beetle host-range expansion threatens the boreal forest. Molecular Ecology (2011) 20, 2157-2171

[2] Safranyik and Carroll. 2006. The Biology and Epidemiology of the Mountain Pine Beetle in Lodgepole pine forests, IN. L. Safranyik and B. Wilson (Eds) The Mountain Pine Beetle: A synthesis of Biology, Management and Impacts on Lodgepole Pine. Pacific Forestry Centre. Victoria, BC.

Figure 4.9 Annual Area Infested by Spruce Budworm and Area Sprayed between 1990-2014



Mountain pine beetle (MPB) is being monitored on an annual basis in two geographic locations: Boreal surveys are being conducted in the northern provincial forest and the second location is in and around Cypress Hills Interprovincial Park in southwestern Saskatchewan.

Currently MPB is not present in the jack pine trees of Saskatchewan's northern provincial forest. MPB has been a natural pest of the lodgepole pine forests in Cypress Hills Interprovincial Park. The last outbreak in the park started in 1980 reaching a peak in 1982 and collapsing by 1984[1]. The current mountain pine beetle control program, which includes systematic and early aerial detection and ground verification and delimitation followed by rapid and aggressive fall and burn action, has shown promising results and has kept losses to a minimum. In 2014 there was an overall reduction in the number of trees controlled in the park, which indicates beetle spread is slowing.

No beetles have been detected since surveillance for the pine beetle began in the northern boreal forest. The annual number of controlled trees in Cypress Hills Interprovincial Park since 2006 is shown in Figure 4.10 on the following page.

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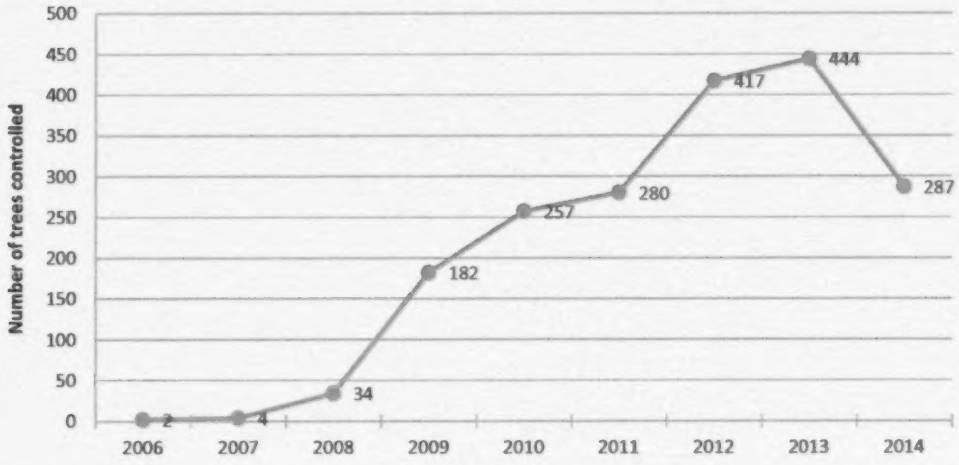
[1] J. Brandt and P. Amirault. 1994. Forest Insect and disease caused depletions to forests in west-central Canada: 1982-87. Natural Resources Canada, Canadian Forestry Service, Northwest Region Northern Forestry Centre, Edmonton Alberta Information Report. NOR-X-333.

Figure 4.10 Mountain Pine Beetle Trees Controlled in Cypress Hills Interprovincial Park (Saskatchewan) 2006-2014



What actions are being taken?

Spruce budworm defoliated areas are mapped each July, using systematic aerial surveys followed by ground verification surveys. Predictions of defoliation for the following year are determined by sampling over-wintering larvae in the autumn. The spruce budworm management program uses specific criteria in selecting areas for treatment, with the objective of keeping economically valuable trees green so they can be harvested within six to 20 years. If required, aerial spraying of the biological pesticide Btk to protect foliage and reduce the impact of spruce budworm feeding occurs during late May or early June.

Saskatchewan has banned the import, transport and storage of pine forest products with bark attached from British Columbia, Alberta and the United States to reduce the risk of human-assisted transport of mountain pine beetle into Saskatchewan.

The ministry conducts extensive aerial and ground-based surveys to detect mountain pine beetles. In September, the ministry conducts rotary wing surveys along the Alberta-Saskatchewan border. These surveys include approximately 1.6 million hectares of pine forests, extending 100 km east from the Alberta border and from the southern forest fringe north to the Churchill River. The ministry also conducts aerial surveys of pine forests located inside and adjacent to the Cypress Hills Interprovincial Park. Extensive ground surveys locate currently infested trees which are marked for fall and burn control.

Aerial and ground surveys have been completed on pine stands within the northern commercial forest and in the Cypress Hills Interprovincial Park. Fall and burn activities have taken place in the Cypress Hills Interprovincial Park where lodgepole pine and mountain pine beetle have coexisted.

Pine forest inventory information in the transitional agriculture lands south of the Crown forest has been collected and linked to the provincial inventory so that the extent of susceptible forests can be used in risk analysis.

In 2011, Saskatchewan and Alberta entered into a multi-year Memorandum of Agreement to implement a collaborative, co-ordinated approach to slowing the eastern spread of mountain pine beetle. In 2014 this agreement was renewed for an additional three years. Under this agreement the province is investing money to combat mountain pine beetle infestations in east-central Alberta to deter the spread into jack pine in Saskatchewan's northern forests.

4.5 Response Indicator: Effective Renewal

Why is this indicator important?

Measures of reforestation are important because forests not sufficiently renewed to maintain their long-term productivity lose their commercial value, leading to socio-economic impacts on northern communities. Improperly renewed forests may also be ecologically different from forests prior to being harvested.

What does this indicator show?

Table 4.3 shows, for each timber licence area in Saskatchewan, the area of forest harvested and the proportion that is sufficiently regenerated (SR) following reforestation efforts. Sufficiently regenerated means 80 per cent of the available growing area is occupied with trees at least 30 cm tall at seven years of age (or 1.5 m tall at 14 years of age). It should be noted that most forests not sufficiently regenerated (NSR) according to this definition are still functioning boreal forest ecosystems, containing significant numbers of trees and wildlife habitats. However, low stocking levels in these areas diminishes their commercial timber value and, for this reason, they are designated as NSR. Table 4.3 and Figure 4.11 also show who is responsible for NSR areas.

Overall, approximately 89 per cent of harvested forest areas in Saskatchewan have been successfully regenerated. Areas with the lowest proportions of successfully regenerated forests are the Island Forests, especially Fort-a-la-Corne, and the Pasquia-Porcupine FMA area. Most NSR forestlands in the province pre-date the establishment of FMAs and are therefore the responsibility of the government to restore to SR status.

Figure 4.11 Provincial NSR Percentage by Forest Area
Total Provincial NSR Area: 12,631 ha

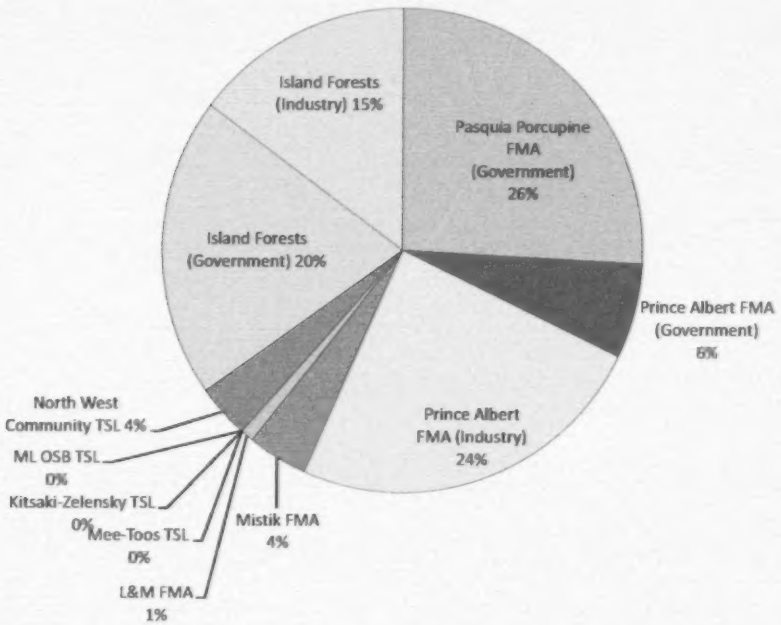

Island Forests (Industry) 15%
Pasquia Porcupine FMA (Government) 26%
Island Forests (Government) 20%
Prince Albert FMA (Government) 6%
North West Community TSL 4%
Prince Albert FMA (Industry) 24%
ML OSB TSL 0%
Kitsaki-Zelensky TSL 0%
Mee-Toos TSL 0%
Mistik FMA 4%
L&M FMA 1%

Table 4.3 Provincial Regeneration Status (2014)

PROVINCIAL FOREST AREA	HARVEST PERIOD	HARVEST AREA (ha)	Survey AREA (ha)	REGENERATION STATUS							
				Sufficiently Regenerated Area (SR)		Not Sufficiently Regenerated Area (NSR)		Not Sufficiently Regenerated Area (NSR)			
						Total NSR		Government Responsibility		Industry Responsibility	
				(ha)	%	(ha)	%	(ha)	%	(ha)	%
PP FMA	2002-2012	43,401	36,687	33,421	91%	3,266	9%	3,266	9%	–	–
PA FMA	2002-2012	69,517	23,765	19,877	84%	3,888	16%	800	3%	3,088	13%
Mistik	2002-2011	55,491	33,965	33,455	98%	510	2%	–	–	510	2%
L&M	2002-2012	7,404	5,647	5,536	98%	112	2%	–	–	112	2%
Meetoos	2002-2012	3,529	1,648	1,648	100%	–	–	–	–	–	–
Kitsaki-Zelensky	2002-2012	–	–	–	–	–	–	–	–	–	–
NWC	2002-2012	237	7,963	7,509	94%	454	6%	–	–	454	6%
Turnor	2002-2012	–	–	–	–	–	–	–	–	–	–
Island Forests	2002-2013	5,717	8,340	3,939	47%	4,401	53%	2,531	30%	1,870	22%
Meadow Lake OSB	2002-2012	7,159	1,891	1,891	100%	–	–	–	–	–	–
Total		**192,455**	**119,906**	**107,275**	**89%**	**12,631**	**11%**	**6,597**	**6%**	**6,034**	**5%**

What actions are being taken?

To finish addressing government renewal obligations on the Pasquia-Porcupine FMA area, stand tending activities will continue to be undertaken to ensure planted trees do not succumb to competing vegetation.

Remaining renewal responsibilities of the previous Prince Albert FMA holder were determined and have been assumed by the new licensee, Sâkaw Askiy Management Inc. Sakaw continues to complete their assumed reforestation obligations and report that activity to government as required.

To address government renewal obligations in the Island Forests, tree planting and site preparation activities commenced in 2011 along with a reassessment of regeneration surveys to better direct renewal efforts in subsequent years. The Island Forest NSR areas are primarily due to a series of fires in the forest in the early 2000s, impacting young plantations. Natural forest regeneration following fire did not occur, leaving areas that require remedial treatment. The ministry anticipates that all treatable NSR areas in the Island Forest will be planted over the next few years.

To assess industry performance against forest management plan assumptions and commitments, audits of industry-submitted regeneration surveys were completed in the summer of 2014 on all FMAs and most term supply licences. These audit results will be reported to senior management and the public in April 2015.

The new Saskatchewan Environmental Code, which includes the Regeneration Assessment Chapter and Standard, has been passed and became effective as of January 5, 2015.

Photo credit: John Daisley, Weyerhaeuser

Giant Boreal Forest Map

The Canadian Boreal Forest Agreement's (CBFA) giant traveling map visited Prince Albert in May 2014. The visit was part of the CBFA's educational campaign, which highlights the forest's economic and environmental importance. The CBFA, which was signed in May 2010, includes seven environmental organizations and 19 forest companies in Canada, of which Weyerhaeuser Saskatchewan Timberlands is a member. The CBFA is a global precedent that integrates economic and environmental values to ensure a sustainable future for the boreal forest, natural habitat, forestry industry and all those whose livelihoods rely upon it. The unique eight-metre by 11-metre mega map of Canada's boreal forest has moved around the country and is used to educate the public about the importance of the boreal forest.

Photo credit: Donna Lundquist, Forest Service Branch

Community Tree Planting on the Canadian Shield

The Flin Flon/Creighton Cubs and Beavers had been planting trees for more than 40 years in the communities of Creighton and Flin Flon. Over the years, trees have been obtained from the Ministry of Environment, Forest Service Branch, PRT Nursery or the SaskPower Shand Nursery. In 2013 the Cubs and Beavers planted trees near the Phantom Lake Golf Course in conjunction with the Flin Flon/Creighton Green Project. Each tree received a scoop of crushed limestone to neutralize the soil.

The Green Project was first started in spring 2000 where a group was established to emulate Sudbury, Ontario by spreading crushed limestone on barren soil to neutralize the acidic soils and stimulate natural plant growth. Since then, the Green Project has treated over 55 ha of barren ground with crushed limestone in the communities of Creighton and Flin Flon. The limestone is a product quarried just south of Creighton and is spread using volunteer labour. The limestone is deposited in piles near the areas to be treated and then volunteers and schools groups haul the crushed limestone in buckets and spread it on the barren soils and rock. The Cubs and Beavers have planted trees on some of the sites over the years. The challenge has been to find sites that had enough soil depth to plant the trees in the ground. www.greenproject.ca/index.html

Photo credit: Dave Stevenson, Forest Service Branch

Forestry Workshop for Teachers

This past August, just before the start of the school year, the Forest Service in partnership with the Prince Albert Model Forest delivered a workshop called Forestry Boot Camp 101 for Saskatchewan high school science teachers. This was the first year of what is planned to be an annual event. The Forestry Boot Camp 101 took 20 participants to natural forest disturbance events such as wildfires and wind damaged forests as well as renewed and active harvest blocks. The participants were shown how lessons learned from naturally occurring patterns and processes on the landscape are used to sustainably manage the forest during industrial activities. The workshop took participants to active Tolko harvest operations near Smoothstone Lake and the recently reopened Carrier Forest Products sawmill in Big River. The participants "roughed it" for several evenings at the Ness Creek festival site which afforded the opportunity to speak with First Nation elders and to see how the forest regenerates itself after intensive human activities such as farming.

Supporting the workshop and the teachers are classroom lesson plans which are available through the Saskatchewan Forestry Association at whitebirch.ca. The workshop was very well received by the participants and plans are already underway for another workshop in 2015.

Wildfire Detection Automation

To protect provincial landscapes and keep Saskatchewan communities safe, the Government of Saskatchewan transitioned from human wildfire tower observers to a centralized monitoring system via remote cameras. Wildfire Management installed 42 wildfire detection cameras across the province's northern forest – the largest wildfire detection camera system in North America. The new system was fully implemented for the 2014 wildfire season.

The technology is operationally proven in North America and provides extensive and reliable information to the Wildfire Management program. The cameras have the ability to operate 24 hours/day and use state-of-the-art visual imaging that provides the same views a human tower observer would see, but with infrared capacity for hazy or smoky conditions, and image storage capability for enhanced wildfire review. The images from all cameras are monitored by specialists at the Provincial Wildfire Centre in Prince Albert. These staff monitor high-risk areas, initiate response in the event of a wildfire, and provide critical information to on-the-ground staff fighting wildfires.

The new system provides technologically progressive wildfire monitoring services to help safeguard northern communities, industry, infrastructure and people from wildfire threat. The centralized system is a cost-effective way to manage not only peak season wildfire starts, but assists during early or late wildfire seasons when towers were traditionally not staffed. Improved response will allow for improved control of wildfires at a smaller size when they are less costly to suppress and pose a reduced threat to public safety, infrastructure and values at risk.

In the future, the network can be enhanced utilizing existing communications towers, providing opportunities to expand the effectiveness, utility and range of the system to further increase benefits to the province. Industry and/or federal partners may also be identified where there is mutual benefit.

Fuel Management Project Protects Stanley Mission from Wildfire

The fuel management (forest thinning) project was completed during the winter of 2008-09 and was funded through the Western Economic Diversification Canada economic stimulus initiative. Based on documented wildfire behaviour and suppression effectiveness, fuel breaks play a significant role in control of wildfire.

On May 24, 2014 at 14:31 hours, a Lagoon Fire was reported within one kilometre of the community of Stanley Mission. Burning conditions were good as the weather was moderately hot and dry and the forest in the area was made up of highly flammable black spruce. The wildfire quickly transitioned from its source, an abandoned campfire, to a full crown fire with winds pushing it towards the community.

Three air tankers (two CL 215s and a CV 580) along with the local fire crew were on the scene of the fire by 14:47 hours. A helicopter (Bell 204 B) joined the effort by bucketing on spot fires in advance of the main wildfire front. Air tanker success was limited as the wildfire was fully engaged so an additional initial attack crew and another CL 215 were added to assist in the effort. The wildfire had grown to 21.4 hectares in size in two hours and 40 minutes despite the aggressive air and ground support effort.

At 16:03 hours the wildfire ran into a fuel management project site located at the edge of the community. It was noted that the wildfire behaviour immediately changed upon entering the thinned area; the high intensity crown fire became a low intensity surface fire allowing the air tankers and ground crews to contain the wildfire. By 17:11 hours the wildfire was no longer advancing and was classed as being held. Thanks to the fuel break, the wildfire was stopped 160 metres from the community's gas station and nearest subdivision. The fuel break played a significant role in the control of the Lagoon Fire and likely prevented the direct loss of structures within the community of Stanley Mission.

View from the edge of Stanley Mission looking towards the fire. This picture was taken just before the fire entered the fuel break as fire behaviour is still extreme. (Wildfire Management Branch May 24, 2014)

Highlights for Forest

The status and trend of the five forest indicators reported on in this chapter are summarized as follows:

4.1 **Forest Type and Age Class** – A variety of forest age classes are represented in the commercial forest. More than half of the commercial forest is currently either mature (70-90 years), old (91-120 years), or very old.

4.2 **Proportion of Provincial Annual Allowable Cut Utilized** – The area of forest harvested each year is much less than that disturbed by wildfires. Forest managers are working to make human disturbances associated with logging to more closely resemble natural disturbances.

4.3 **Forest Wildfire Disturbance** – For 2013 and 2014, the amount of forest burned in the commercial forest zone and forest burned in the entire provincial forest zone are on par or below their respective ten year averages.

4.4 **Forest Insect and Disease Disturbance** – Annual area infested by spruce budworm is well below the ten year average. Currently Mountain Pine Beetle is not present in the jack pine trees of Saskatchewan's northern provincial forest.

4.5 **Effective Renewal** – Harvested areas are effectively being regenerated.

water

Key Points

- Most surface water in Saskatchewan is found in the north, where the demand is lowest.
- The majority of Saskatchewan watersheds have good water quality, but eight southern watersheds are considered stressed.
- More than 30 per cent of the available surface water is used in one quarter of the watersheds in Saskatchewan; all are in the southern half of the province.
- Saskatchewan's per capita water consumption is generally decreasing.

One of Saskatchewan's most prized natural resources is our abundant supply of fresh water. More than 12 per cent of its surface is covered by water and seven per cent of Canada's fresh water can be found in the province. However, most of this water is in the northern half of Saskatchewan where human pressures are low and water supplies are relatively dependable. In the south, where most people live, conditions are semi-arid with a high variability in annual water supply in recent years that has caused situations ranging from drought to flood. As a result, maintaining water quality and a secure water supply is a challenge.

Increasing demand for water by industry and agriculture continues to put pressure on sustainable water allocations (Kulshreshtha et al, 2012). The provincial population continues to increase, and urban populations are growing while rural populations decline (Ministry of Finance, 2011). Climate change is a factor in water supply and demand, and is expected to impact both the timing and amount of water flows throughout the year (Barrow, 2009).

Land use practices contribute non-point source contaminants to surface waterbodies/waterways in the province. Better understanding of the magnitude and ecological effect of non-point sources and best management practices reducing non-point sources of contaminants is required for management of water resources.

Water quality concerns related to nutrient loading, pesticides, heavy metal(s), and emerging substances such as pharmaceuticals continue to be a concern and pose challenges in terms of understanding how best to monitor and mitigate impacts to the provincial water supply.

If anticipated irrigation and mining projects proceed in the southern part of the province, a substantial increase in water use from Lake Diefenbaker and its downstream flow will be required. Servicing more distant projects could involve more careful reservoir management, and the potential need for significant development of delivery mechanisms.

To be proactive in response to these growth opportunities and challenges, the Government of Saskatchewan announced, in October 2012, the formation of the Saskatchewan Water Security Agency (WSA) and the release of the 25-year Saskatchewan Water Security Plan. The Ministry of Environment continues to work closely with the Water Security Agency to ensure source water protection though monitoring of industrial/mining facilities. In

Indicators for Water

Condition

5.1 Surface Water Quality – tracks the trend in Water Quality Index values for the watershed of Saskatchewan.

Stressor

5.2 Surface Water Quantity – tracks the amount of annual flow volume as a percentage of natural flow volume in a river or stream as an indicator of changes in flow regime and water quantity within a watershed.

Response

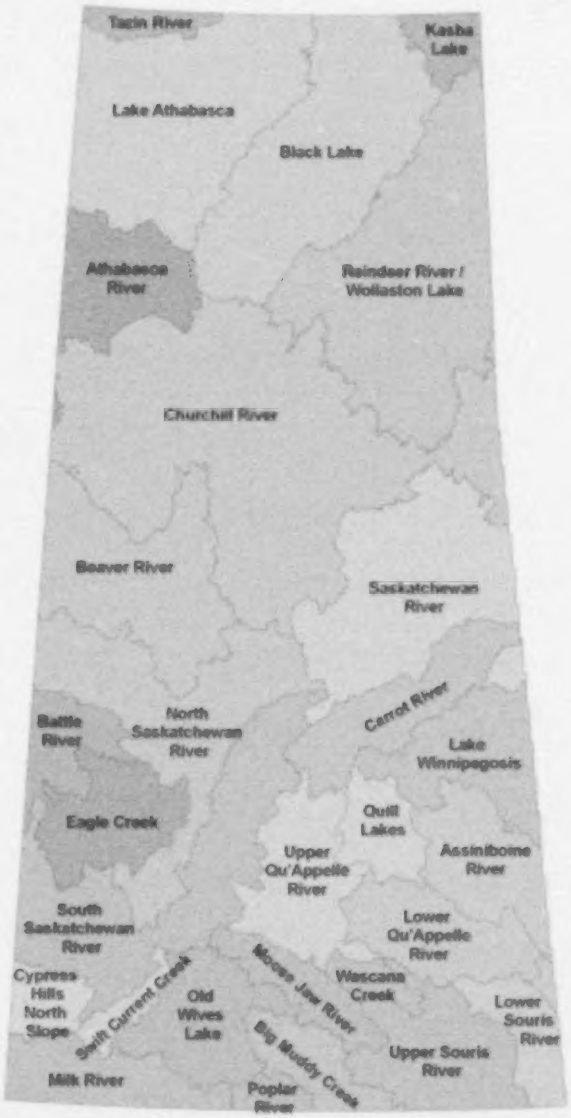
5.3 Water Consumption and Conservation – tracks the changes in municipal water consumption in Saskatchewan's watershed.

addition, a partnership agreement was implemented between the ministry and the Water Security Agency to provide compliance and enforcement services.

Saskatchewan's Watersheds

A watershed, or drainage basin, is a region that drains into a specific body of water, such as a river or lake, and includes all the land, air, plants and animals within its boundary. Each watershed has its own unique mixture of land and water habitats, from wetlands, rivers, and lakes to forests, grasslands, farms and communities. Hills or other heights of land largely determine the boundaries of watersheds, as well as the speed and path of its streams and rivers. All watersheds within Saskatchewan ultimately drain into the Arctic Ocean, Hudson Bay or Gulf of Mexico. For management and reporting purposes, the following water indicators are divided up into 29 watersheds (Figure 5.1).

Figure 5.1 Watersheds of Saskatchewan as Defined by Saskatchewan Water Security Agency



Source: Saskatchewan Water Security Agency

5.1 Condition Indicator: Surface Water Quality

Why is this indicator important?

Water quality can be defined in terms of the chemical, physical and biological characteristics of water and its intended use, including aquatic life. Water quality is affected by a wide range of natural and human influences. A safe and reliable source of water is critical for maintaining healthy ecosystems and human health. In Saskatchewan, the Water Security Agency monitors the water quality of rivers, lakes and streams. The water quality results are used to develop and maintain a baseline for water quality, to assess long-term seasonal and spatial trends, to evaluate the impact of human activities on surface water quality and ultimately to make water management decisions.

One tool used to assess the surface water quality in Saskatchewan is the Water Quality Index (WQI). The purpose of the Water Quality Index is to provide a standardized way of comparing and reporting water quality measurements in our rivers, streams and lakes. The Water Quality Index was created in 1997 by the Canadian Council of Ministers of the Environment (Canadian Council of Ministers of the Environment, 2001). The index assesses the chemical, biological and physical constituents of water at a given place and time. The Saskatchewan Water Security Agency collates the many measurements from a number of monitoring stations throughout the province and summarizes them as follows (Saskatchewan Water Authority, 2010):

- Watersheds scoring between 80 and 100 are considered to be 'Healthy' (i.e. the watershed has no apparent change in function or services provided by water, and the system is both resistant and resilient to change);
- Watersheds scoring between 45 and 79 are considered to be 'Stressed' (i.e. the watershed has no degradation in function and/or services it provides); and
- Watersheds scoring less than 45 are considered to be 'Impacted' (i.e. the watershed has a change and/or degradation in function and/or services).

What does this indicator show?

Figure 5.2 shows the average Water Quality Index values for the watersheds of Saskatchewan from 2004 to 2008. Figure 5.3 shows the average Water Quality Index values for the watersheds of Saskatchewan from 2009 to 2013. To enable comparisons to be made between the two time frames (Figure 5.2 and 5.3) the five-year average for each watershed is only based on water quality sites that were sampled in both time periods. To ensure consistency of reporting, only sites with at least three water quality samples per year, and sites that have WQI values from at least three of the five years within the average are included in this indicator.

Only 12 of the 29 watersheds in the province had water quality sites that were sampled in both time frames (Figure 5.2 and 5.3). The average Water Quality Index for both five-year averages is rated as healthy for nine watersheds (75 per cent) and stressed for three watersheds (25 per cent), including the Battle River, Carrot River and Lower Qu'Appelle River watersheds (Figure 5.3). The Upper Qu'Appelle River Watershed was the only watershed to change its rating. It changed from a rating of healthy in the 2004 to 2008 five-year average Water Quality Index (Figure 5.2) to a rating of stressed in the 2009 to 2013 five-year average Water Quality Index (Figure 5.3). The Upper Qu'Appelle River Watershed moved from a healthy to stressed category is largely due to the increased number of variables analyzed on the Qu'Appelle River sites between 2009 to 2013 as compared to 2004 to 2008 (Figure 5.2 and 5.3).

Figure 5.2 Average Water Quality Index Values by Watershed, 2004-2008

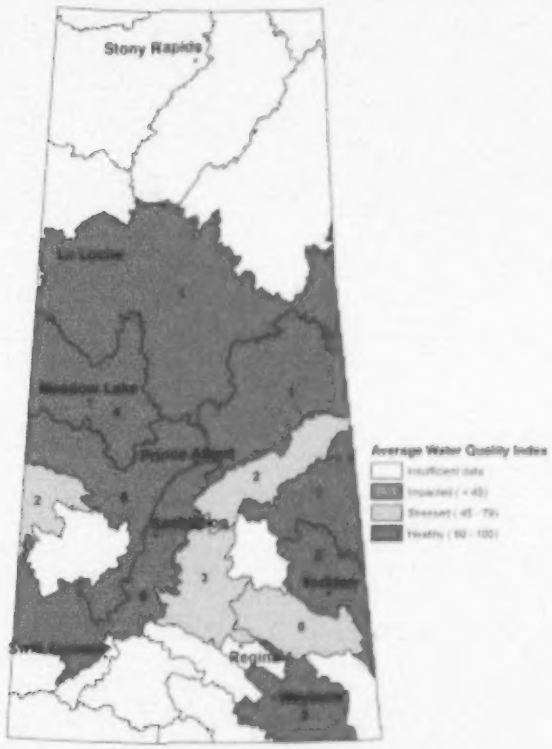
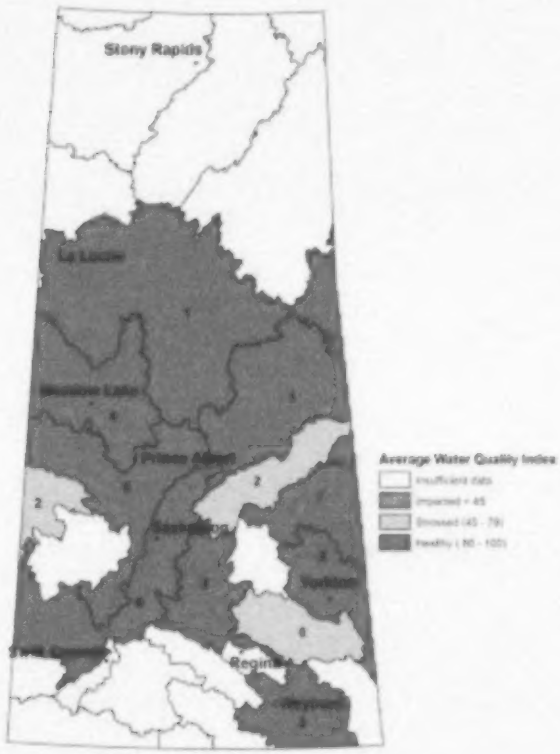


Figure 5.3 Average Water Quality Index Values by Watershed, 2009-2013



Source: Saskatchewan Water Security Agency 2015

Note: The numbers within the watershed boundaries represent the number of sites with WQI values that were used to calculate the average WQI value for the watershed.
Note: Yearly Water Quality Index values from 2004 to 2008 were averaged to obtain the five-year Average Water Quality Index 2004 to 2008. Yearly Water Quality Index values from 2009 to 2013 were averaged to obtain the five-year Average Water Quality Index 2009 to 2013.

Between 2004 and 2008, 81 water quality sites were sampled (Figure 5.2), and between 2009 and 2013, 57 water quality sampling sites were sampled (Figure 5.3). However, only 37 water quality sampling sites were sampled a sufficient number of times in both periods. The lower number of sites in both time periods is due to a number of factors:

a. The Lake Stewardship Program ended in March 2008. The end of this program resulted in the reduction of 19 water quality sampling sites in 17 lakes.

b. The Swift Current Creek Watershed Stewards stopped sampling seven of the eight water quality sampling sites they had previously sampled from 2004 and 2007. The Swift Current Creek Watershed Stewards continues to monitor one water quality sampling site along the Swift Current Creek. However, the water data from this sample cannot be used to obtain a WQI value because there are an insufficient number of quality parameters to calculate the Water Quality Index.

c. The Saskatchewan Ministry of Agriculture and the Water Security Agency (formerly the Saskatchewan Watershed Authority) initiated sampling lower order streams in southern Saskatchewan in 2008.

What actions are being taken?

A range of legislative tools, innovative strategies and policies assist in protecting and improving water quality in Saskatchewan, including:

- The 25 Year Saskatchewan Water Security Plan (Water Security Agency, 2012).
- *The Water Regulations, 2002*, administered by the Water Security Agency and *The Environmental Management and Protection Act, 2002*, administered by the Saskatchewan Ministry of Environment. These acts also define the WSA's provincial authority for aquatic ecosystem protection and the broader aquatic habitat protection objectives.
- *The Fisheries Act*, regulated by Fisheries and Oceans Canada.
- The Interim Surface Water Quality Objectives as determined by the Saskatchewan Ministry of Environment.
- Saskatchewan's Safe Drinking Water Strategy, Government of Saskatchewan 2002.
- In November 2014, Environment Minister Scott Moe announced that the Government of Saskatchewan adopted the new Environmental Code. The Environmental Code, a new regulatory tool, will come into force in stages over 2015. If you would like to learn more about the Environmental Code click on the following link: environment.gov.sk.ca/code.

In addition to legislative tools, there are a number of federal and provincial government programs in the province that monitor the quality of surface and/or ground water for a variety of purposes. These monitoring programs include:

- The Saskatchewan Water Security Agency's Surface Water Monitoring Program
- The Prairie Provinces Water Board's Monitoring Program
- The Saskatchewan Ministry of Environment's Intensive Livestock Operations' Monitoring Program
- The Saskatchewan Ministry of Environment's Cumulative Effects Monitoring Program in northern Saskatchewan, and
- Environment Canada's Environmental Effects Monitoring Program.

At times, more intensive surface water quality monitoring is undertaken to address specific water quality concerns. Such a study was initiated in 2013 to quantify sources of nutrient loading to the Qu'Appelle River from the Qu'Appelle dam to the outflow of Round Lake. Such studies are designed to improve understanding of risks to water quality and provide insight into how management activities can improve water quality.

The Water Security Agency works with community representatives to develop watershed or aquifer plans. Plans include initiatives to help landowners improve watershed health through restoration of riparian areas, protection of wetlands and grasslands, and encouragement of management practices that benefit fish and wildlife. As of November 30, 2014, watershed or aquifer plans are complete, including: the Assiniboine River; Carrot River; Lower Souris River; Moose Jaw River; North Saskatchewan River; South Saskatchewan River; Swift Current Creek; Upper Qu'Appelle River and Wascana Creek; Lower Qu'Appelle River; Upper Souris River; and Old Wives Lake watersheds; and a plan for the Yorkton area aquifers. There are 11 groups that have been formed to implement these plans.

5.2 Stressor Indicator: Surface Water Quantity

Why is this indicator important?

Surface water quantity is the amount of surface water within a watershed. The water depth in a lake or the flow in a river or stream is affected by a number of factors including snowmelt, precipitation, soil infiltration rate, groundwater discharge, evapotranspiration, aquatic fragmentation, water regulation, water withdrawals, and water inputs from human sources such as irrigation, wastewater, and directed storm water runoff. The net available surface water in a watershed can be estimated by subtracting the sum of water allocations and downstream obligations from the estimated natural runoff volume.

Surface water quantity, land management and surface water quality are strongly interconnected. Water shortages can result in deterioration in water quality. Stressors to water supply in Saskatchewan include variability in short-term and long-term weather patterns, and increasing use and diversion in upstream jurisdictions (Saskatchewan Watershed Authority 2007, 2010). Natural fluctuations in stream flows are important for conserving the biodiversity and health of ecosystems such as wetlands and riparian areas. Changes in flow regimes affect the aquatic ecology of these ecosystems and may result in alterations in aquatic habitat, aquatic communities, riparian zones, floodplains, wetlands, stability of river channels, water levels and water quality.

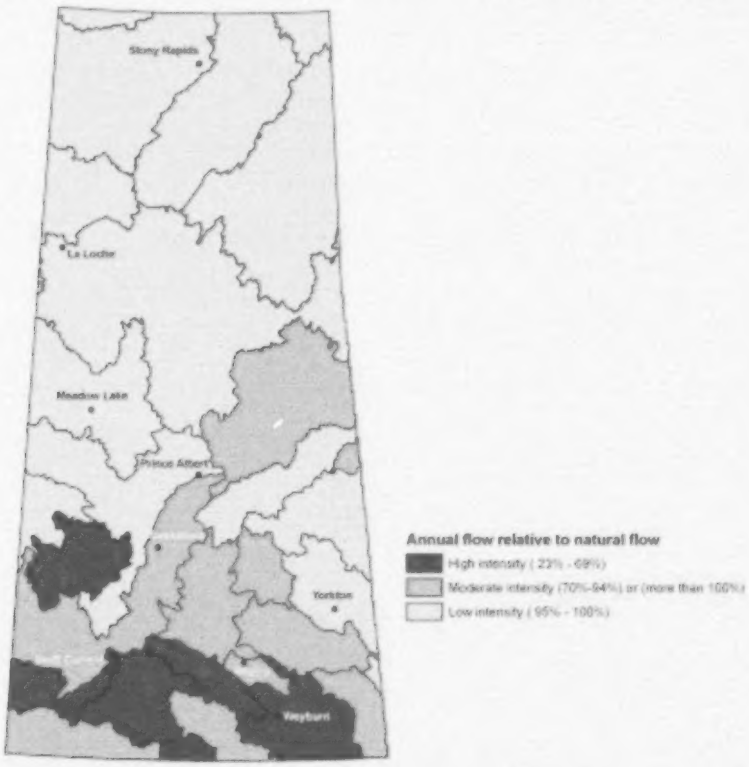
In Saskatchewan, surface water is used for many purposes including human consumption, ecosystem health, recreation, and economic activities such as industrial uses, power generation and agriculture.

What does this indicator show?

Figure 5.4 shows the average annual recorded flow volume as a percentage of natural flow volume for all watersheds in Saskatchewan (Saskatchewan Water Authority, 2010). The indicator is categorized into three classes: low intensity; moderate intensity; and high intensity. Low intensity means 95 to 100 per cent of the water is available to the ecosystem (i.e. recorded flow is 95 to 100 per cent of the natural flow); moderate intensity means 70 to 94 (or more than 100) per cent is available (i.e. recorded flow is 70 to 94 per cent of the natural flow); and high intensity means less than 70 per cent is available (etc.). This indicator is a static indicator that is very useful in telling us how watersheds are different from each other. Because this indicator is based on long-term averages, there will not be major changes between years, but rather this indicator is best for assessing changes over long-time frames. An indicator to assess short-term changes in surface water flow is currently under development.

Seven of the 29 watersheds (24 per cent) are rated as High Intensity and nine (31 per cent) are moderate intensity; all are in the southern half of the province where the human population and demand for water are highest. The Lower Qu'Appelle River and the Upper Qu'Appelle watersheds have recorded flow greater than 100 per cent of the natural flow due to the diversion of water from Lake Diefenbaker through the Qu'Appelle conveyance channel. The remaining watersheds (45 per cent) are all rated as low intensity.

Figure 5.4 Average Annual Recorded Flow Volume as a Percentage of Natural Flow Volume by Watershed, 2010



Source: Saskatchewan Water Security Agency, 2015

What actions are being taken?

To ensure surface water allocation is sustainable at a watershed level, the Water Security Agency (under Authority from *The Water Security Agency Act*) regulates:

- The construction, extension, alteration and operation of any works (e.g. dikes, dams, weirs, floodgates, breakwaters, reservoirs, canals, tunnels, bridges and culverts) in Saskatchewan.
- Surface water allocation by issuing approvals to construct and operate works and water rights licences, with the exception of domestic use.

The Water Security Agency is leading implementation of a number of actions from the 25 Year Saskatchewan Water Security Plan including:

- Developing a modern water allocation system, including a new allocation policy and regulations.
- Reviewing existing water rights licences and assessing current water use.
- At a watershed level, determining the existing use of water, level of protection of environmental flows and how much water is available for future allocation and identifying areas where water scarcity may be a factor.
- Implementing the Water Availability Study including:
  - Preparing a State of the Aquifer System report for Regina East aquifers.
  - Analyzing the water supply situation in the major rivers. Water availability models have been completed for the Souris River and the Qu'Appelle River and the Saskatoon Southeast Water Supply System. Work on a Lake Diefenbaker model and a Swift Current Creek water availability study will start soon.
  - Determining existing water use by sector and delineation by the major basins.
  - Identifying environmental flows to support the aquatic ecosystem.
- Assessing the infrastructure needs to supply water from Lake Diefenbaker to Buffalo Pound Lake to support existing and proposed developments in the Qu'Appelle River watershed.

In Saskatchewan, surface water quantity is monitored co-operatively by the federal and provincial governments through the national hydrometric program. The activities of this program include the collection, interpretation, and dissemination of surface water quantity data and information to decision-makers and the public. Access to surface water quantity data gathered through this program can be found online at:

- The Water Survey of Canada Website, an Environment Canada initiative (ec.gc.ca/rhc-wsc/default.asp?lang=En&n=4EED50F1-1)
- The Saskatchewan Water Security Agency's Provincial Streamflow Forecast Webpage (wsask.ca/en/Lakes-and-Rivers/Stream-Flows-and-Lake-Levels/)

5.3 Response Indicator: Water Consumption and Conservation

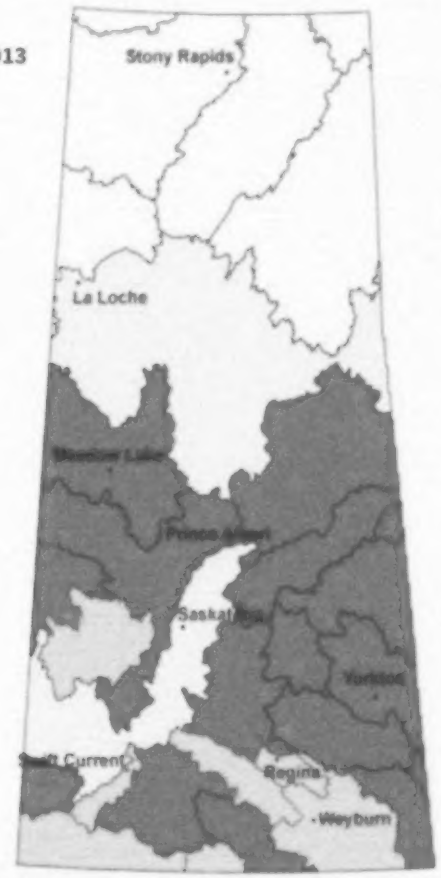
Why is this indicator important?

Water security is the state of having an assured supply of water to meet our needs, for drinking and sanitation, for irrigation and economic growth and for a healthy environment. While Saskatchewan communities generally have a good water supply, water conservation is important for many reasons. Reduced water use lowers total withdrawals, leaving more water for environmental flows and other uses. This becomes particularly important during droughts when water supply is most likely to be a challenge. In addition, conserving water makes sound economic sense. Expanding water delivery systems to support growth requires expensive investments in reservoirs, pipelines and other works. If water conservation steps can keep demand within a community's existing system capacity, significant cost savings are achieved. This applies to both water treatment and waste water treatment systems. Individual water users also save money. In addition, pumping and treating water consumes energy, so reducing water use reduces energy consumption and greenhouse gas emissions.

What does this indicator show?

Figures 5.5 shows the 10-year average municipal water use per capita (2004 to 2013) for 23 of Saskatchewan's 29 watersheds (Water Security Agency, 2015). Water use data is unavailable for the remaining six watersheds. Municipal water use includes water used mainly for residential, industrial, and commercial uses.

Figure 5.5 10-year average daily municipal water use per capita by watershed, 2004 to 2013

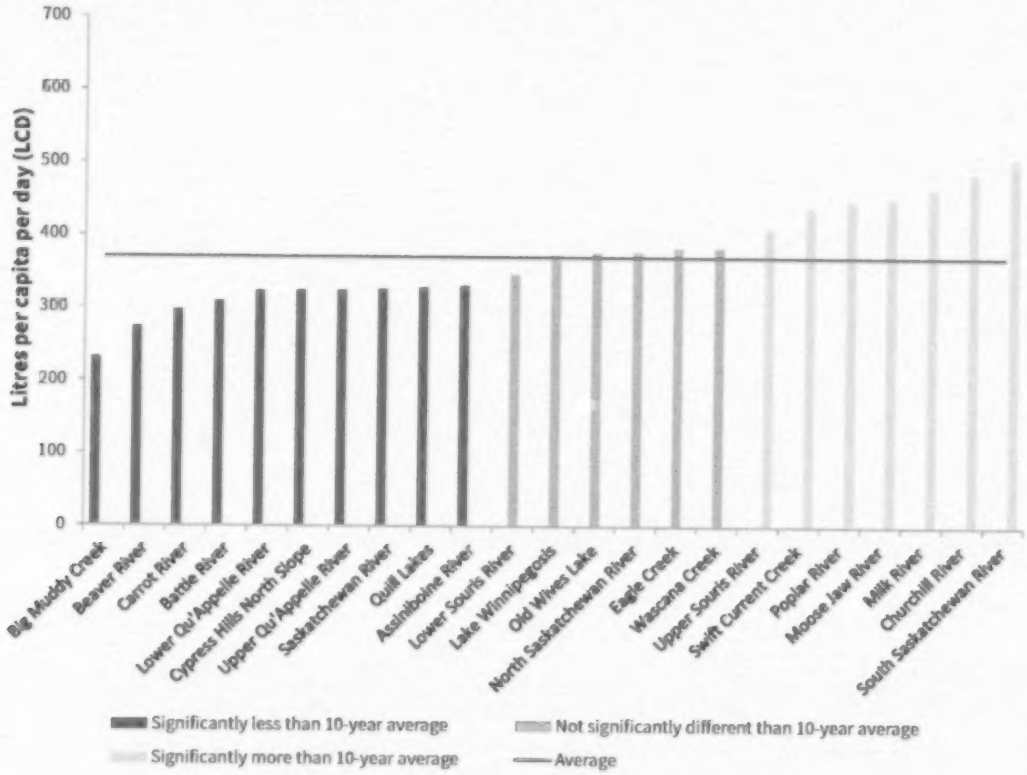


Source: Saskatchewan Water Security Agency 2013

The 10-year average (2004 to 2013) municipal per capita water consumption (Figure 5.5) is rated as less than 381 litres per person per day for 14 watersheds, between 381 and 479 litres per person per day for seven watersheds, and as more than 479 litres per person per day for two watersheds.

Figures 5.6 shows the 10-year average municipal water use per capita (2004 to 2013) for 23 of Saskatchewan's 29 watersheds compared to the provincial 10-year average (2004 to 2013) municipal water consumption per capita (Water Security Agency, 2015). Water use data is unavailable for the remaining six watersheds. Municipal water use includes water used mainly for residential, industrial and commercial uses.

Figure 5.6. 10-year average daily municipal water use per capita by watershed, 2004 to 2013, compared to the provincial 10-year average daily municipal water use per capita



The provincial 10-year average (2004 to 2013) municipal water consumption per capita is 370 litres per person per day. When rating the 10-year average (2004 to 2013) municipal water consumption per capita at a watershed level relative to the provincial 10-year average (2004 to 2013) municipal water consumption per capita it was found that: 10 watersheds used significantly less water than the provincial average; six watersheds did not significantly differ in water use than the 10-year provincial average; and seven watersheds used significantly more water than the provincial average.

Figure 5.7 shows the 10-year average municipal winter versus summer water use per capita (2004 to 2013) by watershed. On average, across the 23 watersheds that had sufficient water use data there was a 17 per cent (Median = 17.5 per cent) decrease in water use in winter relative to summer (Figure 5.7).

Figure 5.8 shows the comparison of the average annual municipal water use per capita by watershed for three different years (2004, 2009, 2013). From this comparison it was found that:

- 12 out of the 23 watersheds decreased their water use between 2004 and 2009.
- 17 out of the 23 watersheds decreased their water use between 2009 and 2013.
- Between 2004 and 2013, 18 out of the 23 watersheds decreased their water use.

Figure 5.7. 10-year Average Municipal Winter versus Summer Water Use Per Capita (2004 to 2013) by watershed

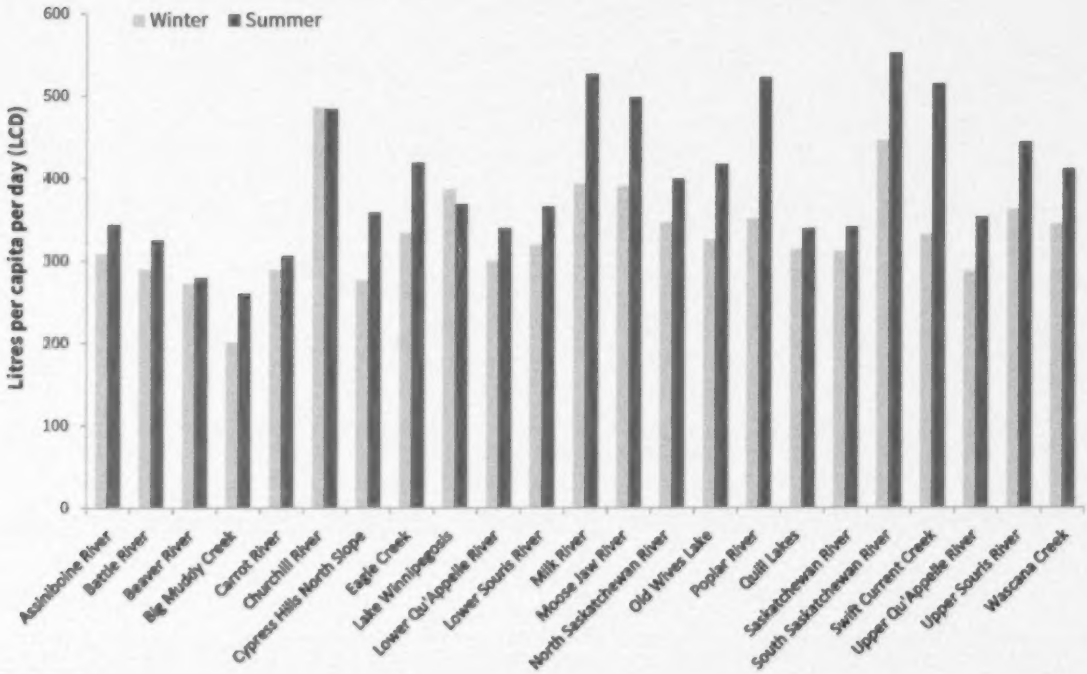
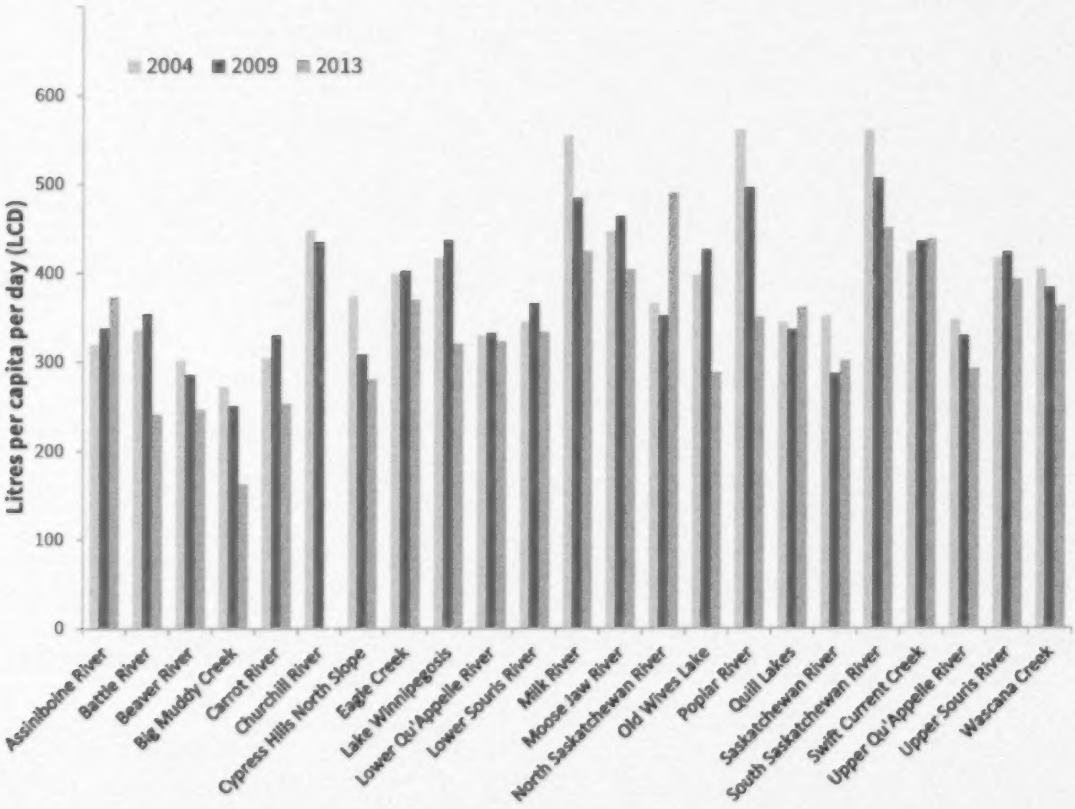


Figure 5.8. Annual Municipal Water Use Per Capita by watershed for three years (2004, 2009, 2013)



What actions are being taken?

1. Providing educational information on water conservation to the public

   Experts within industry have stated that water conservation is a generational shift in attitudes. It is important to start educational/extension activities of any water conservation plan at an early stage.

   In early 2007, the Water Security Agency (formerly Saskatchewan Watershed Authority) launched a public awareness campaign with the theme "The #1 Water Saving Device Is You". This campaign aimed to raise the public's awareness for the need to conserve water, and appeared as radio, TV, print, billboard and web banner advertisements.

2. Promoting the purchase and use of water efficient fixtures

   In 2010, the Water Security Agency (formerly Saskatchewan Watershed Authority) was pleased to partner with the United States Environmental Protection Agency (US EPA) to promote the WaterSense label in Saskatchewan. In August 2010, the Council of the Federation (Canada's Premiers) committed to "encouraging strong water efficiency and quality standards and regulation and the development of a Canada-wide water efficiency labeling program. More information about this program can be accessed at: wsask.ca/Water-Programs/Water-Conservation/WaterSense/.

   On December 31, 2012, the Provincial Toilet Replacement Rebate Program was successfully brought to completion. In January 2009, the Government of Saskatchewan initiated the Provincial Toilet Replacement Rebate Program. This program, was funded through the Go Green Fund and administered by the Water Security Agency to provide a rebate of $50.00 for the purchase of a toilet that uses six litres or less per flush (including dual flush models) when it replaces a higher volume toilet in single family dwellings and multiple-unit complexes (up to a maximum of three toilets per home or unit). During the 51-month program, 65,471 toilets were replaced with water efficient models. Since its inception, the program has saved more than 4.46 billion litres of water, a number which will continue to grow each year.

3. Water loss control

   Water distribution systems naturally deteriorate over time, resulting in water loss. The amount of water loss from these systems is typically 20 to 30 per cent (Cheong 1991). By conducting a water audit, communities can determine water loss that may be due to water distribution system leaks, and can minimize water quality breaches caused by contaminants entering the system through these leaks (Hunaidi et al. 2004).

Boreal Watershed Management Strategy

Canada's boreal forest, including northern Saskatchewan, contains some of the largest and highest quality freshwater resources on earth. The quality of these resources is largely dependent upon the ecological integrity of the watersheds in which they reside.

The five-year Boreal Watershed Management Strategy was established in 2011-12 to assess and maintain the ecological integrity of Saskatchewan's northern watersheds. The project looks at identifying regional environmental responses to multiple land uses. The five-year project is designed to ensure environmental protection of the region.

The initiative is comprised of seven priority or thematic study areas: water quality; aquatic ecosystem health; air quality; soil quality; terrestrial ecosystem health; terrestrial biodiversity; and traditional knowledge. The first two years of the project have focused on gathering information in strategic or sensitive areas, and the development of tools that show promise in long-term monitoring of this vast landscape. Monitoring programs address clean water management strategies, terrestrial ecosystem health (biodiversity strategies) First Nation and Métis traditional knowledge, and legacy data analysis. Year five of the strategy will result in a comprehensive report for the Boreal region that identifies environmental safeguards and thresholds for safe stewardship of the land's resources.

The results of the Boreal Watershed Initiative will form the scientific basis for measuring the sensitivity of the ecosystems to development in the region. The strategy will allow the ministry and key stakeholders, such as industry and northern residents, to evaluate current conditions in northern Saskatchewan, to protect the environment and to help facilitate the sustainable development and growth of northern resources.

Highlights of research work to date includes:

- completion of Boreal and Taiga Eco-zones soil survey, a joint project with Trent University and the University of Saskatchewan. Additional samples were collected, reports and data received and the development of geographic information systems (GIS) is underway. Data will be used as baseline indication of soil qualities and chemistry by many private and public sector organizations;
- in partnership with the Saskatchewan Trappers Association, approximately 200 trapped river otter carcasses were dissected for analysis of metals accumulation. Spatial and temporal patterns in apex predator is underway. Spatial and temporal variations may be related to geologic influences in food chain or anthropogenic inputs;
- in partnership with Health Canada and Environment Canada, an orientation survey was completed on metals detection in bird eggs, a promising early indicator of bio-accumulation of metals and other toxins. The information gathered is also used to monitor for traditional food consumption;
- lake sediment coring in conjunction with the Natural Sciences and Engineering Research Council of Canada and ministry-supported studies at the University of Regina and Queens University to examine subtle changes in lake chemistry and biota through time and to examine specific agents of change such as climate change and oil sands development;
- completed snowpack survey to assess impact of airborne pollutants in northwest Saskatchewan with methods developed jointly with the Joint Oil Sands Monitoring group. Subtle signals in chemistry may be attributable to developments in Alberta;
- wolverine genetic marker survey: field methods were employed successfully with future utility as a genetic mark and re-capture tool is under consideration;
- established partnerships with northern communities and non-government organizations to deliver science-based sampling and environmental awareness of water quality;
- worked jointly with SIAST to deliver a program on using dragonflies as early warning indicators of wetlands;
- worked jointly with Water Security Agency to deliver a sampling program on benthic macroinvertabrates as indicators of water systems in the north; and
- worked with Forestry Research Institute, University of British Columbia and the University of Regina to deliver habitat disturbance maps, fire mapping and footprint mapping (anthropogenic disturbance) for the Boreal Watershed Initiative.

Highlights for Water

Southern Saskatchewan has high demands on its limited water resources, as reflected by the status of the key water indicators and those reported by the Water Security Agency's 2010 State of the Watershed Report. The following is a summary of the status and trend of the three water indicators reported on in this chapter:

5.1 Surface Water Quality – Since 2007, the average Water Quality Index has remained consistent at the individual water quality sampling sites.

5.2 Surface Water Quantity – Seven of the 29 watersheds rated as High Intensity and nine are Moderate Intensity; all are in the southern half of the province where the human population and demand for water are highest.

5.3 Water Consumption and Conservation – On average, across the 23 watersheds that had water consumption data : 10 watersheds used significantly less water than the provincial average; six watersheds did not significantly differ in water use than the 10-year provincial average; and seven watersheds used significantly more water than the provincial average.

With a growing economy and population, demands on Saskatchewan's water resources will increase in the future. An increase in urban populations will require increased capacity for drinking water and wastewater treatment systems. Increasing climate variability, resulting in flooding and drought events, poses challenges in terms of water supply management and demand for improved cross-government planning, flood damage prevention infrastructure and flow forecasting.

Moving Forward

The Saskatchewan Environmental Code contains 16 chapters referencing five regulations and 28 environmental standards. The activities covered include: impacted sites; forest resource management; water mains; sewage mains; hydrostatic testing; halocarbon control; and industrial source air quality.

The Environmental Code provides regulatory certainty for the ministry's stakeholders and the public. With the environmental requirements clearly defined and available for all to see, this clarity will promote compliance and public accountability, and ultimately a safe environment for Saskatchewan people.

As part of successful implementation of the code, internal and external knowledge transfer and consultation is a new focus for the ministry and a vital part of our ongoing work in the results-based changes we are implementing.

In addition to the general public, our regulated stakeholders represent a wide variety of representatives — agrologists, engineers, professional foresters, professional forest technologists, Rural municipality administrators, large industry, small operators and independent consultants who all access and use information differently. State of the environment reporting will continue to evolve in response to public and stakeholder needs amid changing environmental priorities and a drive for continuous improvement in reporting.

State of the environment reporting is an internationally accepted approach to assess and improve our understanding of the environment, to monitor its health, and to inform our decisions and actions for better management.

Given the adoption of a new results-based regulatory system, it makes sense for future state of the environment reporting to not only become more aligned with the new legal framework and its focus on outcomes, but also to achieve greater integration among the various reporting mechanisms in the province. Outcomes such as enhanced environmental stewardship and resource management and harmonization of environmental and resource management policies across government by clearly stating one set of consolidated provisions and improved measures for enforcing environmental protection will be reflected in the 2017 State of the Environment report. (Saskatchewan Ministry of Environment, 2014)

To this end, the Saskatchewan Ministry of Environment will initiate a strategic review of its state of the environment reporting to guide the content and delivery of future reports. Part of this review will determine how the report and reporting framework is positioned both within the ministry and relative to other environmental management, planning and reporting frameworks in Saskatchewan, such as the State of the Watershed, State of Saskatchewan's Provincial Forests, Saskatchewan Environmental Code, and the ministry's performance measures. The review will also explore the possibilities for web-based reporting and continuous updating as currently adopted by other jurisdictions.

References

State of Environment Reporting in Saskatchewan

Saskatchewan Environment. 2003. Saskatchewan's 2003 State of the Environment Report: A Provincial Perspective. Regina, SK: Saskatchewan Environment.

Saskatchewan Environment. 2005. Saskatchewan State of the Environment Report 2005. Regina, SK: Saskatchewan Environment.

Saskatchewan Environment and Public Safety. 1991. Saskatchewan State of the Environment Report. Regina, SK: Saskatchewan Environment and Public Safety.

Saskatchewan Environment and Resource Management. 1993. Saskatchewan's State of the Environment Report – The Need for Environmental Indicators 1992. Regina, SK: Saskatchewan Environment and Resource Management.

Saskatchewan Environment and Resource Management. 1995. Saskatchewan's State of the Environment Report 1995 – The Boreal Plain Ecozone: A Forest Community. Regina, SK: Saskatchewan Environment and Resource Management.

Saskatchewan Environment and Resource Management. Saskatchewan's State of the Environment Report 1997 – The Prairie Ecozone: Our Agricultural Heartland. Regina, SK: Saskatchewan Environment and Resource Management.

Saskatchewan Environment and Resource Management. Saskatchewan's State of the Environment Report 1999 – The Boreal Shield Ecozone: A Land of Lakes and Forests. Regina, SK: Saskatchewan Environment and Resource Management.

Saskatchewan Environment and Resource Management. Saskatchewan's State of the Environment Report 2001 – Taiga Shield Ecozone: Land of the Caribou. Regina, SK: Saskatchewan Environment and Resource Management.

Saskatchewan Ministry of Environment. 2009. Saskatchewan's 2009 State of the Environment – State of Saskatchewan's Provincial Forests. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/soereport

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report.

environment.gov.sk.ca/2013soereport

Saskatchewan Ministry of Environment. 2011. Ministry Overview. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/ministry-overview/

Saskatchewan Ministry of Environment 2014. Changing How we do Business. An introduction to Results-based Regulations and the Saskatchewan Environmental Code. Retrieved from environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=d86280e5-e1c1-4138-b41d-bb8b36e30fa4

Saskatchewan Watershed Authority. 2007 State of the Watershed Report. Regina, SK: Saskatchewan Watershed Authority.

Saskatchewan Watershed Authority. 2010. 2010 State of the Watershed Report. Regina, SK: Saskatchewan Watershed Authority. Retrieved from wsask.ca/Global/About%20WSA/Publications/State%20of%20the%20Watershed/a_2010StateoftheWatershedReport.pdf

Saskatchewan Watershed Authority. 2011. Annual Reports/Performance Plans. Regina, SK: Saskatchewan Watershed Authority. Retrieved from finance.gov.sk.ca/PlanningAndReporting/2010-11/201011SWAAnnualReport.pdf

Air

Alberta Environment. 2008. Alberta Air Emissions Trends and Projections. Edmonton, AB: Alberta Environment. Retrieved from environment.gov.ab.ca/info/library/7964.pdf

CBC, 2014. Major Train Derailment and fire near Wadena, Sask. October 7, 2014. cbc.ca/news/canada/saskatchewan/major-train-derailment-and-fire-near-wadena-sask-1.2791337 Accessed January 6, 2015

CCME. 2010. Particulate Matter and Ground-level Ozone – Canadian-wide Standards for Particulate Matter (PM) and Ozone. Ottawa, ON: Canadian Council of Ministers of the Environment. Retrieved from ccme.ca/ourwork/air.html?category_id=99

Comprehensive Air Management System (CAMS) Steering Committee 2010. Comprehensive Air Management System: A Proposed Framework to Improve Air Quality Management. Comprehensive Air Management System (CAMS) Steering Committee.

Environment Canada. 2000. NPRI in Ontario. Retrieved from on.ec.gc.ca/pollution/npri/npri_ontario_1998_e.pdf

Environment Canada. 2010. Pollutants. Ottawa, ON: Environment Canada. Retrieved from ec.gc.ca/Air/

Jeffries, D.S. R.G. Semkin, J.J. Gibson, and I. Wong. (2010). "Recently surveyed lakes in northern Manitoba and Saskatchewan, Canada: characteristics and critical loads of acidity." J. Limnol. 69(Suppl. 1): 45-55.

NPRI 2010. National Pollution Release Inventory. Ottawa, ON: Environment Canada. Retrieved from ec.gc.ca/inrp-npri/

Saskatchewan Ministry of Environment. 2009. Results-Based Regulatory Model – A Review of The Environmental Management and Protection Act, 2002: [proposed amendments to The Environmental Management and Protection Act, 2002]. Regina, SK: Saskatchewan Ministry of Environment.

Saskatchewan Ministry of Environment 2010. Annual Report 2009-2010. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from finance.gov.sk.ca/PlanningAndReporting/2009-10/200910EnvironmentAnnualReport.pdf

Saskatchewan Ministry of Environment. 2011. Saskatchewan Air Quality Data. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/airqualityindex

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report.

environment.gov.sk.ca/2013soereport

Scott, K. A., B. Wissel, J.J. Gibson, and S.J. Birks (2010). "Chemical characteristics and acid sensitivity of boreal headwater lakes in northwest Saskatchewan." J. Limnol. 69(Suppl. 1): 33-44.

SESAA. 2010. Southeast Saskatchewan Airshed Association. Further information from sesaa.ca/home/index.php

Climate

Balshi, M., A.D. Mcguire, P. Duffy, M. Flannigan, J. Walsh and J. Melillo. 2009. "Assessing the response of area burned to changing climate in western boreal North America using a Multivariate Adaptive Regression Splines (MARS) approach." Global Change Biology 15: 578-600.

Barrow, E. 2009. Climate Scenarios for Saskatchewan. Prairie Adaptation Research Collaborative (PARC). Regina, SK: University of Regina. Retrieved from parc.ca/pdf/research_publications/renamed/PP2009-01_web.pdf

Carr, A., P. Weedon and E. Cloutis. 2004. Climate Change Implications in Saskatchewan's Boreal Forest Fringe and Surrounding Agricultural Areas. Climate Change Action Fund. Ottawa, ON: Natural Resources Canada. Retrieved from for.gov.bc.ca/hfd/library/documents/bib99631.pdf

Environment Canada. 2004. Canada's greenhouse gas inventory 1990-2002: Greenhouse gas emission summary, 1990-2002. Ottawa, ON: Environment Canada. Retrieved from publications.gc.ca/collections/Collection/En49-5-5-10-2-2002E.pdf

Environment Canada. 2010a. National Inventory Report 1990-2008. Greenhouse Gas Sources and Sinks in Canada. Ottawa, ON: Environment Canada

Environment Canada. 2010b. National Inventory Report 1990-2008. Greenhouse Gas Sources and Sinks in Canada. Saskatchewan Greenhouse Gas Emission Summary. Ottawa, ON: Environment Canada.

Hogg, E.H. and P.Y. Bernier. 2005. "Climate change impacts on drought-prone forests in western Canada." Forestry Chronicle 81: 675-682.

IPCC 2007. IPCC Fourth Assessment Report: Climate Change 2007 (AR4). Geneva, Switzerland: Intergovernmental Panel on Climate Change. Retrieved from ipcc.ch/publications_and_data/publications_and_data_reports.shtml

Saskatchewan Bureau of Statistics. 2010. Economic Accounts. Regina, SK: Bureau of Statistics. Retrieved from stats.gov.sk.ca/stats/ER2010.pdf

Saskatchewan Ministry of Environment 2010. Climate Change. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from publications.gov.sk.ca/deplist.cfm?d=66&c=822

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report. environment.gov.sk.ca/2013soereport

Sauchyn, D., Barrow, E., Fang, X., Henderson, N., Johnston, M., Pomeroy, J., Thorpe, J., Wheaton, E., and Williams, B. 2009. Saskatchewan's Natural Capital in a Changing Climate: An Assessment of Impacts and Adaptation, Summary Document. Prairie Adaptation Research Collaborative (PARC), Regina, SK: University of Regina. Retrieved from parc.ca/pdf/research_publications/summary_docs/SD2009-02.pdf

Tans, P. 2010. Trends in Atmospheric Carbon Dioxide. Earth Systems Research Laboratory. National Oceanic and Atmospheric Administration. Retrieved from esrl.noaa.gov/gmd/ccgg/trends/

World Resources Institute. 2003. WRI's Annual Carbon Dioxide Inventory Report (2003). Washington DC: World Resources Institute (WRI).

Land

CCPCCP. 2011. CropLife Canada Pesticide Container Collection Program. Fact sheet. Retrieved from saskh20.ca/PDF/EPB395.pdf

Clean Farms Inc, 2013 Annual Report. Retrieved From cleanfarms.ca/sites/default/files/annualreports/cleanfarms_ar2013_en.pdf

De Groot, R.S., R. Alkemade, L. Braat, L. Hein, L. Willemen. 2010. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity 7 (2010) 260-272.

Eilers, W., R. MacKay, L. Graham and A. Lefebvre (Eds). 2010. Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #3. Ottawa, ON: Agriculture and Agri-Food Canada. Retrieved from publications.gc.ca/collections/collection_2011/agr/A22-201-2010-eng.pdf

Electronic Products Recycling Association (EPRA) Annual Report 2013. Retreived from

epra.ca/wp-content/uploads/ar/english/2013/EPRA2013%20-%20Annual%20Report.pdf

Federal, Provincial and Territorial Governments of Canada. 2010. Canadian Biodiversity: Ecosystem Status and Trends 2010. Ottawa, ON: Canadian Councils of Resource Ministers. Retrieved from biodivcanada.ca/A519F000-8427-4F8C-9521-8A95AE287753/EN_CanadianBiodiversity_FULL.pdf

Gray, R. 2010. It All Makes Cents: The Economics of Conservation Tillage. In: Lindwall, W. and B. Sonntag (Eds.). Landscapes Transformed: The History of Conservation Tillage and Direct Seeding. Knowledge Impact in Society. Saskatoon, SK: University of Saskatchewan (pages 149-161). Retrieved from kis.usask.ca/ZeroTill/LandscapesTransformed_HistoryofCT_Book.pdf

Hofmann, N. 2008. Conventional tillage: How conventional is it? Ottawa, ON: Statistics Canada. Retrieved from statcan.gc.ca/pub/16-002-x/2008003/article/10688-eng.htm

PCAP. 2010. Saskatchewan Prairie Conservation Action Plan – Framework 2009-2013. Regina, SK: Prairie Conservation Action Plan. Retrieved from pcap-sk.org/docs/PCAP_2009-2013_Framework.pdf

Prospectors and Developers Association of Canada. 2011. Environmental Excellence in Exploration initiative. Toronto, ON: Prospectors and Developers Association of Canada, Retrieved from pdac.ca

Recycle Saskatchewan. 2014. Saskatchewan Waste Reduction Council. Saskatoon, SK: Recycle Saskatchewan. Further information from recyclesaskatchewan.ca/images/about/library/reports/RecycleSask_2014Statistical_Booklet_WEB.pdf

SARCAN Recycling. 2011. Saskatchewan Association of Rehabilitation Centres. Saskatoon, SK. Further information from www.sarcan.ca/faqs

SARCAN Recycling. 2014. Saskatchewan Association of Rehabilitation Centres. Saskatoon, SK. Further information from sarcan.ca/pages/history

SARRC. 2014. Saskatchewan Association for Resource Recovery Corporation 2013 Annual Report. Saskatoon, SK.

Retrieved from usedoilrecyclingsk.com/webcura/files/284563_2013-sarrc-annual-report-final.pdf

Saskatchewan Mining Association. 2014. General Information. Regina, SK. saskmining.ca/uploads/general_files/24/sma_general-fact-sheet-2014.pdf

Saskatchewan Ministry of Agriculture. 2011a. Agricultural Statistics. Regina, SK: Saskatchewan Ministry of Agriculture. Retrieved from agriculture.gov.sk.ca/agriculture_statistics/

Saskatchewan Ministry of Agriculture. 2011b. Personal communication: Ken Panchuk. Production Technology Unit. Regina, SK: Crops Branch, Saskatchewan Ministry of Agriculture.

Saskatchewan Ministry of Energy and Resources. 2009. Saskatchewan Mineral Lands Activity maps in Saskatchewan Ministry of Environment. Toward a Results-Based Regulatory System. Regina, SK: Clifton Associates Ltd.

Saskatchewan Ministry of Economy 2014. Saskatchewan Exploration and Development Highlights 2014, Saskatchewan Geological Survey. Regina, SK: Retrieved from economy.gov.sk.ca/SEDH12014

Saskatchewan Ministry of Economy 2015. Land Tenure – Statistics. Regina, SK: Retrieved from economy.gov.sk.ca/Default.aspx?DN=3698,3402,3384,2936,Documents

Saskatchewan Ministry of Environment. 2008. Saskatchewan Paint Stewardship Program. Fact sheet. Regina, SK: Saskatchewan Ministry of Environment.

Saskatchewan Ministry of Environment 2010. Annual Report 2009-2010. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from finance.gov.sk.ca/PlanningAndReporting/2009-10/EnvironmentPlan0910.pdf

Saskatchewan Ministry of Environment. 2011a. Joint Federal – Provincial Panel on Uranium Mining Developments in Northern Saskatchewan: Status of Recommendations.

Saskatchewan Ministry of Environment. 2011b. Lands Branch. Regina, SK: Saskatchewan Ministry of Environment.

Saskatchewan Ministry of Environment. 2011c. Recycling. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from: environment.gov.sk.ca/Default.aspx?DN=22fb9d52-7265-42aa-973d-3274ab62da25

Saskatchewan Waste Reduction Council. 2011. Saskatoon, SK. Further information from saskwastereduction.ca

Saskatchewan Watershed Authority. 2010. 2010 State of the Watershed Report. Regina, SK: Saskatchewan Watershed Authority Retrieved from: wsask.ca/Global/About%20WSA/Publications/State%20of%20the%20Watershed/a_2010StateoftheWatershedReport.pdf

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report. environment.gov.sk.ca/2013soereport

SCDC. 2010. Species at Risk in Saskatchewan. Regina, SK: Saskatchewan Conservation Data Centre.

SSCA. 2010. Saskatchewan Soil Conservation Association. Indian Head, SK. Further information from ssca.ca/

SSTC. 2014. Saskatchewan Scrap Tire Corporation. Regina, SK. Further information from scraptire.sk.ca/News/

Statistics Canada. 2009a. Total land area and use of farm land, Canada and provinces, census years 1976 to 2006 – Saskatchewan. Ottawa, ON: Statistics Canada. Retrieved from statcan.gc.ca/pub/95-632-x/2007000/t/4185579-eng.htm#47

Statistics Canada. 2009b. Tillage practices used to prepare land for seeding, Canada and provinces, census years 1991 to 2006 - Saskatchewan. Ottawa, ON: Statistics Canada. Retrieved from statcan.gc.ca/pub/95-632-x/2007000/t/4129758-eng.htm#47

Stewart, I. 2006a. Land Use. The Encyclopedia of Saskatchewan. Regina, SK: University of Regina. Retrieved from esask.uregina.ca/entry/land_use.html

Stewart, I. 2006b. Municipal Road Network. The Encyclopedia of Saskatchewan. Regina, SK: University of Regina. Retrieved from esask.uregina.ca/entry/municipal_road_network.html

SWEEP 2011. Saskatchewan Waste Electronic Equipment Program. Regina, SK. Further information from sweepit.ca

West, T.O. and W.M. Post. 2002. Soil Organic Carbon Sequestration by Tillage and Crop Rotation: A Global Data Analysis. Carbon Dioxide Information Analysis Center. U.S. Department of Energy. Oak Ridge, Tennessee, U.S.A: Oak Ridge National Laboratory. Retrieved from cdiac.ornl.gov/programs/CSEQ/terrestrial/westpost2002/westpost2002datatable.pdf

Wicklum, D. and B. Gray. 2010. Impact of Conservation Tillage on Landscape and Ecological Services: Challenges and Opportunities. In: Lindwall, W. and B. Sonntag (Eds.). Landscapes Transformed: The History of Conservation Tillage and Direct Seeding. Knowledge Impact in Society, Saskatoon: University of Saskatchewan (pages 199-205). Retrieved from kis.usask.ca/ZeroTill/LandscapesTransformed_HistoryofCT_Book.pdf

Forest

British Columbia Ministry of Forests, Lands and Natural Resource Operations website, Frequently Asked Questions website, 2012. for.gov.bc.ca/hfp/mountain_pine_beetle/faq.htm#3

Canadian Council of Forest Ministers. 2003. Defining Sustainable Forest Management in Canada. Criteria and Indicators – 2003. Ottawa, ON: CCFM Secretariat. Retrieved from ccfm.org/english/coreproducts_ci2003.asp

Logan, J. A., and J. A. Powell. 2004. Ecological consequences of climate change altered forest insect disturbance regimes. In F. H. Wagner (Ed.), Climate change in western North America: evidence and environmental effects. Lawrence, Kansas, U.S.A.: Allen Press.

PARC. 2010. Research summary documents. Regina, SK: Prairie Adaptation Research Collaborative. Retrieved from parc.ca/research_summaries.htm

Saskatchewan Ministry of Environment. 2009. Saskatchewan's 2009 State of the Environment – State of Saskatchewan's Provincial Forests. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/soereport

Saskatchewan Ministry of Environment. 2013a. Wildfire Management Strategies. Regina, SK: Saskatchewan Ministry of Environment. environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=74abdce5-64bd-4846-a681-1ea3a2e2e26e&MediaID=78ebbe3a-bd20-4f92-9a5d-

020e4c34461d&Filename = Wildfire + Management + Strategies.pdf&l = English

Saskatchewan Ministry of Environment. 2013b. Forest Fire Management Strategy Zones in Saskatchewan Prepared by Wildfire Management Branch. Prince Albert, SK: Saskatchewan Ministry of Environment. Retrieved from http://www.environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID = cea6727c-c18f-486d-a20a-0ce1275dbc8c&MediaID = 7199ab60-9fd1-495d-b546-40548738ef4f&Filename = Strategy + Zones + 2013 + - + MAP.pdf&l = English

Saskatchewan Ministry of Environment. 2013c. Forest Fire History 1945-2013. Prepared by Wildfire Management Branch. Prince Albert, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/Default.aspx?DN = e3b65a62-d11c-4a21-bd82-5247414d0f7d

Saskatchewan Ministry of Environment, 2011. 2011 State of the Environment Report.

environment.gov.sk.ca/soereport2011

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report.

environment.gov.sk.ca/2013soereport

Scientific America Wildfire Smoke Proves Worse for Global Warming. Elizabeth Harball and ClimateWire (with permission from Environment & Energy Publishing, LLC. eenews.net).

Water

Barrow, Elaine. April 2009. Climate Scenarios for Saskatchewan. 135pp. parc.ca/pdf/research_publications/renamed/PP2009-01_web.pdf

Environment Canada. 2010. 2010 Municipal Water Use Report: Municipal Water Use 2006 Statistics. Ottawa, ON: Environment Canada. Retrieved from publications.gc.ca/collections/collection_2010/ec/En11-2-2006-eng.pdf

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report.

environment.gov.sk.ca/2013soereport

Saskatchewan Ministry of Environment 2014. Annual Report 2013-2014. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from http://www.environment.gov.sk.ca/annual-report/

Saskatchewan Ministry of Finance. 2011. Saskatchewan Population Report, 2011 Census of Canada. 9pp. stats.gov.sk.ca/stats/population/Censuspop2011.pdf

Health Canada. 2008. Guidelines for Canadian Drinking Water Quality. Federal - Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health. Ottawa, SK: Minister of Health. Retrieved from hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index-eng.php

Saskatchewan Environmental Society. 2009. Water Use in Your Home: What you need to know to use less and spend less.

Saskatchewan Watershed Authority. 2006. State of the Watershed Reporting Framework. Regina SK: Saskatchewan Watershed Authority.

Saskatchewan Watershed Authority. 2007 State of the Watershed Report. Regina, SK: Saskatchewan Watershed Authority.

Saskatchewan Watershed Authority. 2010a. Authority website.

Saskatchewan Watershed Authority. 2010b. 2010 State of the Watershed Report. Regina, SK: Saskatchewan Watershed Authority. Retrieved from wsask.ca/Global/About%20WSA/Publications/State%20of%20the%20Watershed/a_2010StateoftheWatershedReport.pdf

Kulshreshtha, S., A. Bogdan, and C. Nagy. 2012. Present and Future Water Demand in Selected Saskatchewan River Basins. A report prepared for the Saskatchewan Watershed Authority. 440pp. wsask.ca/Global/Lakes%20and%20Rivers/Provincial%20Forecast/2014/Selected%20Saskatchewan%20River%20Basin%20Water%20Demand%20Study.pdf

Moving Forward

Saskatchewan Ministry of Environment. 2009. Toward a Results-Based Regulatory System. Regina, SK: Clifton Associates Ltd.

Saskatchewan Ministry of Environment. 2011a. Results-Based Regulations. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/Regulations

Saskatchewan Ministry of Environment. 2011b. Saskatchewan Environmental Code. Regina, SK: Saskatchewan Ministry of Environment. Retrieved from environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID = d86280e5-e1c1-4138-b41d-bb8b36e30fa4

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report.

environment.gov.sk.ca/2013soereport

Acronyms

Saskatchewan Ministry of Environment, 2013. 2013 State of the Environment Report.

environment.gov.sk.ca/2013soereport

Glossary

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List of Acronyms

AAC	Annual Allowable Cut
AQI	Air Quality Index
AQMS	Air Quality Management System
ASFP	Association of Saskatchewan Forestry Professionals
BEMLOSS	Baseline Environmental Monitoring of Lower Order Streams in Saskatchewan
CAAQS	Canadian Ambient Air Quality Standards
CACs	Criteria air contaminants
CCME	Canadian Council of Ministers of the Environment
CCPCCP	CropLife Canada's Pesticide Container Collection Program
CDC	Code Development Committee
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canada-wide Standard
DUC	Ducks Unlimited Canada
e3	Environmental Excellence in Exploration
ECRF	Emissions Control Research Facility
FMA	Forest Management Agreement
FMPs	Forest management plans
FRZ	Full Response Zone
FSC	Forest Stewardship Council
GDP	Gross domestic product
GHG	Greenhouse gas
HLA	Hydraulic Launch Assist
HVS	Harvest Volume Schedule
IPPC	Intergovernmental Panel on Climate Change
MMRP	Multi-material recycling program
NAPS	National Air Pollution Surveillance
NCC	Nature Conservancy of Canada
NFI	National Forest Inventory
NPRI	National Pollutant Release Inventory
NPSS	Native Plant Society of Saskatchewan
NSR	Not sufficiently regenerated
PARC	Prairie Adaptation Research Collaborative
PCAP	Prairie Conservation Action Plan
PM	Particulate Matter
RAN	Representative Areas Network
SAML	Saskatchewan Air Monitoring Laboratory
SAARC	Saskatchewan Association for Resource Recovery Corporation
SASC	Saskatchewan Agriculture Stewardship Council
SESAA	Southeast Saskatchewan Airshed Association
SFA	Saskatchewan Forestry Association
SFVI	Saskatchewan Forest Vegetation Inventory
SOEEA	Saskatchewan Outdoor Environmental Education Association
SR	Sufficiently Regenerated
SRC	Saskatchewan Research Council
SSCA	Saskatchewan Soil Conservation Association
SSTC	Saskatchewan Scrap Tire Corporation
SWA	Saskatchewan Watershed Authority
SWEEP	Saskatchewan Waste Electronic Equipment Program
SWF	Saskatchewan Wildlife Federation
TSL	Timber Supply Licence
VOCs	Volatile Organic Compounds
WYAMZ	Western Yellowhead Air Management Zone
WSA	Water Security Agency
WQI	Water Quality Index

Glossary

Acid deposition - the process by which acids are deposited, either by wet deposition in the form of rain, snow, sleet, hail or fog, or as dry deposition in the form of particulates such as fly ash, sulphates, nitrates, or as gases like sulphur dioxide (SO2) and nitrogen oxides (NOx).

Agro-ecosystem - species and ecosystems under agricultural management; an open, dynamic system connected to other ecosystems through the flow of energy and the transfer of material such as crops, pastures, livestock, other flora and fauna, air, soil and water.

Air Quality Index - is an indicator of air quality, based on air pollutants that have adverse effects on human health and the environment. The pollutants are sulphur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), carbon monoxide (CO), and fine particulate matter (PM).

Air zone - is a geographic region that shares the same air quality characteristics. The air zone boundaries may be established considering topographic features, meteorology, economic activities, pollution sources, political boundaries and common air quality issues.

Ambient - surrounding, or on all sides.

Biodiversity (biological diversity) - refers to the wealth of life forms on earth, including plants, animals, micro-organisms, the genes they possess and their habitats.

Boreal forest - consists of a vegetation type dominated by coniferous trees, especially black and white spruce, balsam fir or larch, interspersed with deciduous trees such as birch and aspen.

Carbon sequestration - the provision of long-term storage of carbon in terrestrial or aquatic ecosystems, or underground, so that the buildup of carbon dioxide (a major greenhouse gas) concentration in the atmosphere will be reduced.

Carbon sink - an area where the rate of carbon uptake by living organisms exceeds the rate of carbon release.

Climate change - an alteration in measured quantities (e.g. precipitation, temperature, radiation, wind, cloudiness) within the climate system, that is significantly different from previous average conditions and is seen to endure, bringing about corresponding changes in ecosystems and socio-economic activity.

Condition indicators - represent the health or status of both the structure and services of the environment, and how the structure and services function together.

Coniferous - evergreen shrubs and trees characterized by needle-shaped leaves, cones and a resinous wood.

Criteria air contaminants (CACs) - emissions of criteria air contaminants contribute to smog, poor air quality and acid rain. CACs include total particulate matter (TPM), particulate matter with a diameter less than 10 microns (PM10), particulate matter with a diameter less than 2.5 microns (PM2.5), carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), volatile organic compounds (VOC) and ammonia (NH3).

Deciduous - plants which shed their leaves or needles at a particular season, usually autumn.

Ecoregion - broad integrated land area characterized by a unique combination of landscape, physiography and ecoclimate within the Ecological Land Classification (ELC) System.

Ecosystem - the interaction of plants, animals, other organisms and non-living components, which function together to circulate nutrients and create a flow of energy.

Emissions - polluted gases, particles or liquids released into the atmosphere.

Emission sources -

- open sources: emission sources that emit air contaminants over large geographical areas, primarily in a stationary but non-point source manner, and are diffuse in nature. Examples include dust from farms, construction and paved and unpaved roads.
- natural sources: emission sources such as biogenic emissions from vegetation, biological and geological sources and wildfires.

- industrial sources: emissions sources such as mining, upstream oil and gas, petroleum refining, steel production, chemicals, asphalt plants, pulp and paper and grain industries.
- non-industrial sources: emission sources such as power generation utilities, commercial and residential fuel combustion and residential fuel wood combustion.
- mobile sources: transportation emission sources such as wheeled vehicles, ships, aircraft and railroad locomotives.

Evapotranspiration - the movement of water from the soil and plant communities to the atmosphere by evaporation of water from the soil and transpiration of water by plants.

Forest Management Agreement (FMA) - an agreement entered into by the Minister pursuant to The Forest Resources Management Act, where the term of the agreement is not to exceed 20 years, with provisions setting out the rights of the licensee for the harvesting of forest products and the responsibilities of the licensee for the renewal of specified forest products.

Fugitive emissions - air pollution derived from human activities that do not emanate from a particular point, such as an exhaust pipe or stack. Roadway dust and volatile organic compounds (VOCs) from refinery valves are examples of fugitive emissions.

Greenhouse gases - gases such as carbon dioxide, methane, chlorofluorocarbons, nitrous oxide and water vapor that trap heat in the Earth's atmosphere and contribute to global warming.

Hectare - one hectare is the equivalent of 10,000 m2 (0.01 km2) or 2.471 acres. A hectare could also be considered the area of slightly less than three Canadian football fields.

Indicator - physical, chemical, biological or socio-economic measures used to simplify, describe, monitor and interpret environmental functions.

Legislation - the act or process of making laws.

Micron - 39.37 millionths of an inch, or 0.001 millimetre.

NSR (Not Sufficiently Regenerated) - is defined as an area not meeting regeneration standards.

Non-point source - a source of atmospheric, aquatic or terrestrial pollution in which naturally occurring or human-created pollutants are discharged over a widespread area or from a number of small inputs, rather than from one distinct, identifiable source (point source).

Particulates - fine liquid or solid particles that remain suspended in the air for any length of time such as dust, smoke, mist, fumes or smog found in the air of emissions. Particulate matter can be broken down into the following categories:

Total particulate matter (TPM): any particulate matter with a diameter less than 100 microns.

- particulate matter less than or equal to 2.5 microns (PM2.5): any particulate matter with a diameter less than or equal to 2.5 microns.
- particulate matter less than or equal to 10 microns (PM10): any particulate matter with a diameter less than or equal to 10 microns.

pH - an expression of the intensity of the basic or acidic condition of a liquid or of soil generally expressed on a scale ranging from 0 to 14 where values below seven are acidic, seven is neutral and values above seven are considered alkaline.

Point sources - any stationary source that usually releases emissions through stacks or other emissions sources, for which individual source records are maintained in the inventory and for which annual emissions exceed a specified cut-off level.

Policy - a defined course of action adopted by an organization or government.

Provincial forest - any Crown resource land designated by the Minister pursuant to section 12 of The Forest Resources Management Act.

Response indicators - represent the management activities implemented to mitigate the stress and improve the health of the environment

Riparian - transition zones between land and water environments pertaining to anything connected with, or immediately adjacent to, the banks of a lake, river or other body of water.

Seral stages - a broad range of forest stand ages across landscapes. Seral-stage communities consist of vegetation types that are adapted to the site's particular set of physical and biotic conditions. In the unmanaged forested landscape, various natural disturbance agents (such as fire, windthrow, landslides, and insects) are responsible for creating forests containing a full range of stand ages.

Species - a group of individuals that share certain physical characteristics and are capable of producing fertile offspring.

- endangered: species on the verge of immediate extinction or extirpation.
- extinct: species that no longer exist anywhere.
- extirpated: species no longer found in the wild in Canada, although they may exist elsewhere.
- threatened: species likely to become endangered if the pressures from human or natural causes threatening them are not reversed.
- vulnerable: species at risk because of low numbers or restricted range; although not in immediate danger, they could be at any time.

Stakeholders - the people or groups with a direct or indirect interest, or "stake," in an issue.

Stewardship - judicious use and care of the Earth's resources.

Strategy - an action plan designed to achieve a specific goal.

Stressor indicators - represent human activities that have the potential to impact the health or condition of the environment.

Summerfallow - land that has no crop for one year and is either tilled or chemically treated to control weeds.

Tillage - mechanical preparation of the soil for seeding, fallow or weed control.

Timber Supply Licence (TSL) - a licence granted by the Minister pursuant to The Forest Resources Management Act conferring the right to harvest specified forest products for a set number of years.

Water Quality Index (WQI) - an index used to measure and summarize how well individual water bodies meet surface water quality objectives.

Watershed - a geographic area defined by topographic elevation divides that has a common outlet for its surface runoff.

Zero-tillage - a one-pass operation that places seed and fertilizer into an undisturbed seedbed, packs the furrow and retains adequate surface residues to prevent soil erosion.